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AUTHOR	Taylor, James B.; And Others
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ABSTRACT

Fairgoers, who attended the United States Science Exhibit at the Seattle World's Fair and therefore were exposed to the elaborate attempt at mass education that it represented, were studied as if they were "students." Attitudes towards science and scientists, information retention, and background characteristics were measured. Attendance and crowd flow patterns were studied. General reactions to the science exhibit were surveyed. In the report of these studies, tentative conclusions are arrived at on the psychology of exhibit design. The research strategy and interviewing techniques used in the studies are explained. (MF)

SCIENCE ON DISPLAY:

A Study of The United States Science Exhibit Seattle World's Fair, 1962

INSTITUTE FOR SOCIOLOGICAL RESEARCH
University of Washington
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SCIENCE ON DISPLAY:

A STUDY OF THE UNITED STATES SCIENCE EXHIBIT

SEATTLE WORLD'S FAIR, 1962

By

James B. Taylor

With

Lynn Blackwell, Allan Dorius, Louis Gray
Otto Larsen, Kiyoshi Tagashira, and the
Opinion Research Laboratory of Seattle

Institute for Sociological Research
Otto N. Larsen, Director
University of Washington
Seattle, Washington

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INTRODUCTION

On April 21, 1962, the Seattle World's Fair opened its doors to the public. For a World's Fair it was small, but not without its unique aspects. Outstanding among these was the United States Science Exhibit. Here five gleaming buildings, covering six and one-half acres, presented the history, philosophy, and findings of present-day science. The atmosphere was one of elegant solemnity. Avoiding an emphasis on "better things for better living," "engineering miracles," or Sunday-supplement marvels, the displays showed instead the mood and texture of scientific work. Science was portrayed as a human endeavor, springing from curiosity, and resulting in a sense of wonder at the lawful complexity of the universe. The exhibit attempted to give "a collection of impressions, experiences, sights and sensations linked together to produce entertainment and enlightenment."[1] Not surprisingly, it quickly became a focal point for the entire fair.

The average fairgoer perhaps thought of the Science Pavilion in many ways: as a spectacle, as an extravaganza, as a thing of beauty. It was all of these. But in the paper which follows, attention will be focused on only one of its facets. We shall consider the United States Science Exhibit as an unusually elaborate attempt at mass education.

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1. Spilhaus, A, "Aims of the United States Science Exhibit," in Souvenir Guide Book, United States Science Exhibit, World's Fair in Seattle, 1962.

The Pavilion's five great halls covered the full range of modern scientific knowledge, from sub-atomic physics to operant conditioning. The past of science was emphasized, as well as its present. Displays reviewed the work of Kepler, Faraday, Darwin, Mendel, and many others. Nor were the techniques of science slighted: one hall was devoted entirely to the specific ways in which scientists find answers to their questions. Other halls dealt with the public implications of science, with the role of the creative imagination in science, etc. A month could have been spent in the pavilion without exhausting its educational riches.

The Science Exhibit, like most museums and halls, represents a peculiarly modern kind of education. Traditionally, learning is a person-to-person process. The teacher may chat with a single student; may lead a small band of graduates in discussion; or may lecture to a sea of scribbling freshmen. One person, the expert, talks to others. But teaching at the Science Pavilion was impersonal, carried on by machines, by displays, by movies. The "students" came partly to learn, partly to be entertained. They stood briefly before exhibits, faceless members of a crowd. They were distracted by children tugging at their arms, by the pushing flow of people, by tight schedules. In many ways they were more like a TV audience than like students. The Science Exhibit, then, attempted to provide education for a mass audience, using the most sophisticated available techniques of mass communication.

How well did it succeed in its educational task? This question must be asked of any teaching, but for the Science Exhibit it is central. Classroom education draws on much practical experience, and on considerable research. But teaching by exhibits has been little investigated. What do viewers learn? Is information communicated? Do attitudes change? What are the potentials and limitations of exhibit teaching? To these queries there have been no answers.

Before the Fair opened, it occurred to several people that the United States Science Exhibit might serve as an ideal natural laboratory for studying such questions. Doctor Albert Parr, of the American Museum of Natural History, and Doctor Daele Wolfle, of the American Association for the Advancement of Science, expressed informal interest; it was largely through their impetus that a few psychologists and sociologists at the University of Washington began thinking about the problem. Professor Bud Horton, of the Psychology Department, aroused the interest of the present Project Director, who in turn enlisted the aid of Doctor Otto Larsen. After many conferences, an initial outline of a research project took shape.

Since we were investigating a little-explored subject, it seemed most appropriate to start with general and broad-ranging questions. We saw ourselves as a scouting party, mapping the main features of an unknown territory. Our hypotheses were very general, our approach correlational and descriptive. The main tool was the polling interview. We hoped that from this initial work would come more specific hypotheses, testable under controlled experimental conditions.

Funds for the research were granted by the National Science Foundation. We gratefully acknowledge the assistance of George J. Rothwell, who at the time of the grant was Head of the Office of Science Exhibits. The project began March 15, 1962. We were fortunate in being able to subcontract the interviewing to the Opinion Research Laboratory of Seattle, under Mrs. Edith Dyer Rainboth and Miss Marilyn McCurtain. The interviewing crews began their work on June 15, 1962, continuing until October 20; in that time over 9,000 people were sampled. As well as conducting interviews, the Opinion Research Laboratory developed background questions and did much of the editing and coding necessary with the interview protocols.

The following pages detail our thinking and work; the development of questionnaires; the problems encountered in the field, the interviewing procedures, and the results to date.

As with any team project, each aspect of the research benefited by the thinking of the entire group. Nevertheless, specific individuals undertook specific tasks; whatever success the project achieved is due to their labors. The research personnel and their particular roles are listed below:

- Lynn Blackwell. Administrative Assistant and coordinator, office manager. Developed and conducted the "General Poll" reported in Chapter X.

- Allan Dorius. Developed information scales. Developed teaching machine programs. Responsible for the time-lapse photographs and their analysis.

- Louis Gray. Developed information scales. Developed teaching machine programs. Responsible for the mechanical phases of the teaching machine interviews.

- Kiyoshi Tagashira. Developed attitude measures. Developed necessary computer programs and supervised data analysis.

Two other graduate students, each with the project for a brief time, made significant contributions: David J. Smith, in conducting the early open-ended attitude interviews, and J. Gerald Fortis, in helping with the initial administrative arrangements.

Miss Patricia Dowling and Miss Allison Jensen contributed their secretarial skills to the project, also at times doubling as interviewers, coders, and chauffeurs. Their versatile assistance is gratefully acknowledged.

A number of other people and organizations have contributed materially to the project also. The Educational Science Division of U. S. Industries, Incorporated, made available to us several Autotutor teaching machines, and the accompanying Baranoff printers. Mr. Jean Hart aided us greatly in adapting these machines to our rather unusual needs. The staff of the Science Pavilion were unfailing in their courtesy and help: we are especially indebted to Mr. Courtland Randall, Mr. Leonhard Nederkorn, Mr. Edward Feeney, Mr. Edward Devine, Mr. Craig Colgate, and Dr. Athelstan Spilhaus.

This list would not be complete without acknowledging the invaluable assistance of Dr. Albert Parr, of the American Museum of Natural History, New York. In his two visits to the project as consultant, he freely contributed the insights and sensitivities gained in a lifetime of work with museum displays.

Seattle, 1963

CHAPTER I

RESEARCH STRATEGY AND TACTICS

We began the project with two main queries: "Do attitudes change after exposure to the U.S. Science Pavilion?" and "How effective is the Science Pavilion in imparting information?" More specifically, we asked the following questions:

(1) What groups of people are most likely to be attracted to exhibits of this kind? It is possible that significant portions of the population are not reached by this medium; if so, it would be useful to pinpoint such limitations of appeal.

(2) What changes take place in attitudes towards science as a result of viewing such exhibits? Implicit in the development of the Science Pavilion is the hope that the displays will quicken interest and broaden understanding; an evaluation of these hopes would seem useful.

(3) How effective are the displays in imparting specific scientific information? The scientific display is designed to communicate specific information; its effectiveness as an educational medium warrants study.

(4) What kinds of displays seem most effective in producing changes in information or attitudes? The Science Pavilion uses a broad spectrum of display techniques; it seems worthwhile to evaluate the relative effectiveness of different display parameters.

Measuring Attitudes

Information and attitudes.......On the face of it, measuring information is not a particularly difficult problem; one finds out what is being taught, and asks questions to see if it is retained.

But "attitudes" are more nebulous, especially if we consider under this rubric such things as "stereotypes," "the role of science in government" and so on. We somehow needed to take this nebulous variable and make it more concrete, more manageable.

After considerable reading and free-response interviewing, we decided to query the public on four main attitude variables:

(1) Stereotypes of scientists--Are scientists timid or adventurous? Eccentric or conventional? Boring or interesting? Etc.

(2) Stereotypes of science--is science intelligible or unintelligible? Valuable or worthless? Constructive or destructive? Etc.

(3) The meaning of scientific endeavor--What things distinguish science from other human pursuits? Is it basically any search for truth? A matter of logical thinking? An attempt to make the world a better place? Etc.

(4) The potentials of science--Will science be able to change heredity? Create life? Eliminate poverty and crime? Enable man to land on the moon? Etc.

These four general variables could easily lead to an infinite number of specific questions. So before doing any interviewing at the Fair, several months were given to developing brief, comprehensive attitude questions. This work is described in Chapter II. It resulted in a 45-item attitude questionnaire, taking 15-20 minutes to complete.

Do attitudes change as a result of viewing displays? Perhaps the simplest way of finding out would be to ask people questions before they entered the Science Pavilion, and again when they emerged.

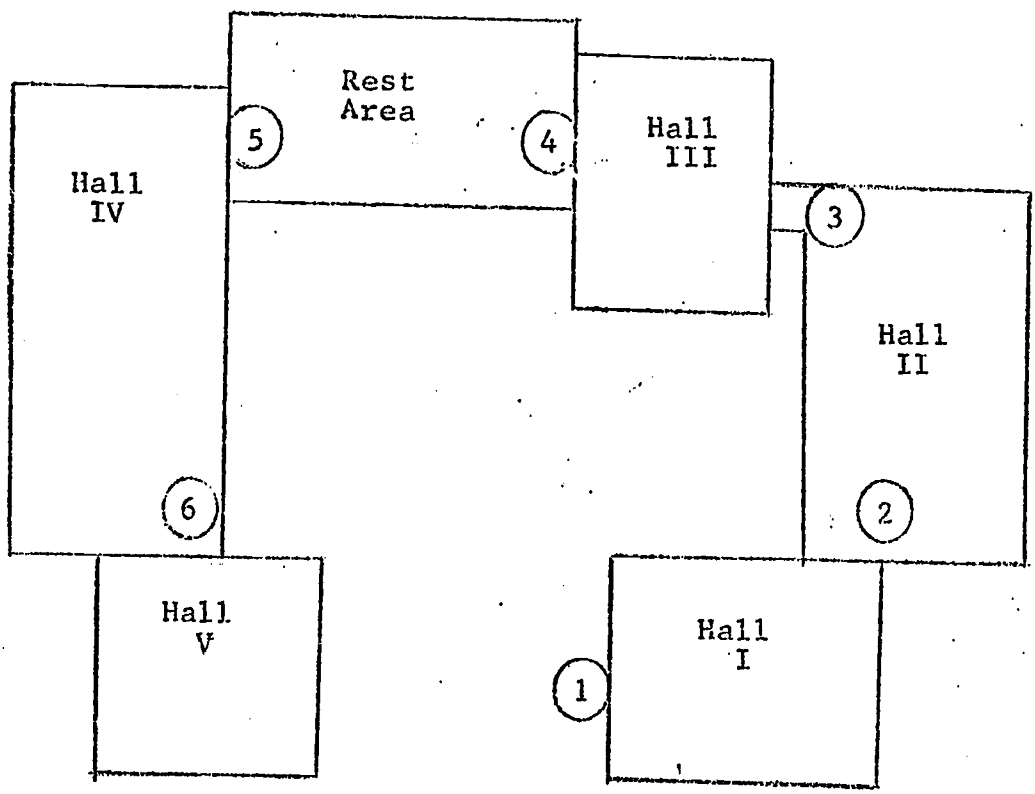
Thus one would have a before-and-after comparison of the same sample. Practical problems made this simple design unworkable: it was difficult to catch the same people at both the entrance and the exit of the Pavilion. We feared also that two interviews a day would alienate even the most cooperative respondent. Instead, it was decided to sample one group of people before they entered the Science Pavilion, and another--quite independent--group on emergence.

This would have given us a simple study, one which lent itself to neat before-and-after comparisons. But such simplicity was not to be.

Crowd flow patterns turned out to be exceedingly complex. People did not pass in a steady continuous stream through the five buildings. Instead, they overflowed from every exit in the pavilion; they left the Rest Area to wander back to the other exposition halls; they started in the middle of the Pavilion to avoid the initial waiting lines; they entered in doors marked EXIT....Our initial hopes of a simple before-and-after sample proved ill-founded.

Sampling necessarily became more complex. Instead of interviewing people at the entrance and the exit, it was necessary to interview them at the major waypoints throughout the entire Pavilion. Altogether, six sampling areas were used. Their placement is shown in Figure1:1. Although adding to the complexity, this strategic change allowed a more precise measurement of the Science Exhibit's effects. We could find out the attitude changes occurring in response to the film in Hall I, to the highly complex exhibits in Hall IV, to

The United States Science Exhibit



Placement of the Six Sampling Areas

Figure 1:1

the simulated trip through space in Hall III. We could further find out what kinds of people were interested enough to continue all the way through, and what people dropped out as soon as possible. Correcting for complexity thus made possible a more articulated picture of the viewing experience.

Measuring Information Retention

We had expected that the measurement of information retention would prove simpler than the measurement of attitude. It was perhaps simpler in theory, but hardly in practice.

Success in imparting information was measured for a single building of the Science Pavilion: Hall IV. The largest building in the complex, it showed the methods of science as applied to specific research problems. Here were a multitude of display techniques, a multitude of appeals and topics, all designed to communicate highly specific information. People were sampled as they entered the building; a second independent sample was interviewed on exit. It soon became obvious that a variety of information scales would be needed. The richness and complexity of the displays precluded a single, simple, questionnaire.

The team began by analyzing the information content of each exhibit; from this analysis, a series of multiple-choice questions were constructed. The amount of potential information is shown by the number of pretest questions which resulted--approximately 450 multiple-choice questions being written!

Four months were spent in preparing these questions, and their analysis. Picked for the final questionnaire were the clearest, least ambiguous, and most discriminating items. Their selection is described in detail in Chapter III.

From this work came eight brief information scales, each covering a single broad content area. They were:

(1) Biology (16 items)

(2) Nuclear Physics (16 items)

(3) Behavior (12 items)

(4) Botany (6 items)

(5) Applied Physics (16 items)

(6) Macrophysics (16 items)

(7) Human Physiology (16 items)

(8) Geology (6 items)

The two shortest scales, each of six items, were combined into a single group of items on all questionnaires.

The same questions were asked before and after people had viewed Area IV. Both groups received a background questionnaire and (approximately) 32 information items.

These data allow an item-by-item analysis of learning in Hall IV. They show the areas in which information increased, and the areas in which little information was retained. Thus we will be able to answer not only the general question, "Do people learn anything?"--but can also pinpoint just what had been learned, and from which displays.

Finding Background Information

Who visited the Science Pavilion? Does such an exhibit appeal to some groups more than others? Do some population groups show an especially large change in attitudes? In information? To answer such questions, considerable background information was necessary for each respondent. The following kinds of data were gathered:

(1) Socio-economic background--Type of work, Rural-urban residence, Income, Education, Class status as described by self.

(2) Science background and interest--Number and subjects of science classes taken in high school and college, Self-descriptive rating of interest in science.

(3) Circumstances of the visit to the Science Pavilion--Number of people accompanying the respondent, Exhibits recommended to respondent, Exhibits he would recommend, Exhibits that he was told to avoid.

(4) Religious preference and frequency of church attendance.

(5) Age, Sex, Home state or country.

The specific questions were, when appropriate, coded so as to allow comparison with U.S. Census data. In addition to these variables, a subsample of respondents was given a General Science Information test, to ascertain their background knowledge. Chapter IV reports the background questions in greater detail.

Problems of Sampling

Some of the sampling difficulties have been discussed before: i.e., the complex patterns of crowd flow which forced the gathering of data from six interviewing areas. But there were other complexities as well. These are discussed in Chapter V ; here we shall only point to some of the major complexities and their implications.

Statistically, a crowd is a moving mass, made up of individual bits. From this moving mass the interviewing crew was to pick a sample entirely at random, making sure that each individual had an equal chance of being interviewed on every questionnaire.

What kinds of things might interfere with this purely random sampling? In the first place, the interviewers might bias it by choosing certain types of people to be interviewed. To avoid this, respondents should be chosen completely at random. Secondly, the interviews had to be spaced so that differential attendance patterns would not bias the sample. All tests had to be given with equal frequency in the morning, afternoon, or evening, and at the beginning, middle, and end of the week. A third source of error--more difficult to control--lay in the differential refusal rates. People in two areas stood in line waiting for a movie, while in the other areas they moved steadily along. As might be expected, the samples differed between different interviewing areas, producing a systematic bias.

The first of these problems--bias in choosing the respondent--was minimized by adopting a random selection method. Respondents were drawn from certain pre-selected spots in the interviewing area; when an individual passed by such a spot he was approached for interviewing, the specific spot varying on a rotational basis.

The second problem--bias from differences in temporal attendance patterns--was met by sampling at each interviewing area throughout the day, and at the beginning, middle, and end of the week. Scheduling and budget complexities did not allow a complete systematic balancing of these variables; Chapter V presents the interviewing schedule and the number of interviews of all sorts for each time period.

Biases arising from differential refusal rates were not correctable in the field. The interviewers polled all respondents who would talk to them. Still, it was possible to look at the collected data, form some conclusions about the sampling bias, and make a few tentative corrections. If, for instance, fewer college graduates were interviewed in Area I than in the other areas, the sample from I could be adjusted so that the college graduates were not under-represented in the final tabulations. The nature of such adjustments, and their rationale, is spelled out in Chapter V.

Developing Interview Techniques

Interviewing at a Fair presents unique technical difficulties. The average man-in-the-street pollster stops a person at random, asks a few questions, and goes on to the next respondent. But in our case the interviewer had to interrupt a busy man, a person often accompanied by spouse and children, and ask him for a twenty-minute interview. This was sometimes seen as an imposition. The interview content was threatening as well, the usual first response being, "But I don't know anything about science." The information questions were similar to school exams and were far from easy. Noise level during the interview was usually high. To meet these difficulties, several novel interview techniques were developed.

In assessing attitudes, conversation was largely avoided. The questions were placed on a thin metal sheet; the respondent answered by placing a magnetic button on the board. Thus he could change his answers if he wished. The magnetic board technique also avoided whatever negative connotations might have existed with paper-and-pencil tests. It had the further advantage of novelty, people appeared to enjoy playing with the magnets and watching them cling to answers.

Two procedures were used in administering information questionnaires. The first technique made use of the magnetic boards described above, the respondent "checking" his answer with a plastic button. The second approach was with an automated teaching machine and recorder, the "Autotutor." Altogether 2,602 information interviews were gathered with the magnetic boards 1,480 with the teaching machines.

In these teaching machine interviews, the respondent was confronted by a metal box the size of a portable TV set. To one side were ten buttons; in the center was a ground glass screen. Instructions and multiple-choice questions were flashed on the screen. The respondent indicated his answer by pushing one of the buttons, the push being recorded on paper tape. We hoped that the novelty and impersonality of this mechanical interview would lessen resistance to abstruse questions about the Mohorovicic discontinuity, DNA, imprinting, etc.

The majority of the interviewers were female college students, employed on a part-time basis. Each interviewing crew was made up of a single crew leader and five or more interviewers. The average interviewing day was five hours; a longer working day tended to produce fatigue. Each interviewer acted at times as a spotter for the team, approaching prospective respondents and requesting their help.

The initial explanation varied; we soon found that a "standard" approach settled into a routine-sounding patter after a while. In general, something like the following was said:

> Hello. I'm from the University of Washington. We are doing a poll about the Science Pavilion. You have been chosen as one of the people that we would like to interview.

Further explanations were given as necessary. Needless to say, volunteer respondents were not accepted.

Measuring Crowd Flow

In analyzing the effectiveness of specific displays, it is necessary to know which exhibits were most successful in attracting viewers. It is also useful to know how successful the entire Science Exhibit was in attracting its potential audience--the average fair-goer.

The attractiveness of specific displays was assessed only in Area IV, the same area where the information questions were asked. In order to record crowd flow, time-lapse cameras were mounted above the crowd, focusing with wide-angle lenses on specific exhibits. An exposure was made every fifteen seconds; 100 feet of film recorded an entire viewing day. The films were analyzed with the aid of a special projector; they provided data on the number of people passing a specific exhibit, the average viewing time, and the larger patterns of crowd flow throughout the hall. These analyses could then be coordinated with specific exhibit variables, and with scores on scales of information retention. Complete findings from this phase of the project are not yet available; it is anticipated that they will form part of a doctoral dissertation by A. Dorius. However, certain preliminary results are reported in Chapter IX.

In analyzing total Pavilion attendance, students were used instead of cameras. During a seven day period in July, from 9 a.m. to 9 p.m., undergraduates stood outside the Pavilion complex, recording every person who entered and departed. From these data came estimates of the size of the Pavilion audience as compared to the total fair attendance by days; the hourly, daily, and weekly crowd flow through the buildings; and the pattern of crowd flow by particular entrances and exits. A replication of this crowd count was made during a three-day period in October. These studies are described in greater detail in Chapter VIII.

In Brief:

1. Using the United States Science Exhibit as a natural laboratory, four main questions were investigated--

- What groups of people are attracted to scientific displays?
- What attitude changes take place after viewing scientific exhibits?
- How effective are such displays in imparting specific information?
- What kinds of displays are most effective in producing attitude or information changes?

2. Four types of attitude variables were investigated, the interviews being conducted so as to get a before-and-after sample from each area of the Science Pavilion. The variables were:

- Stereotypes of scientists.
- Stereotypes of science.
- The meaning of scientific endeavor--the basic nature of science.
- The potentials of science.

3. Eight information scales were developed, and administered to people entering and leaving Area IV of the Pavilion. Information items were drawn from displays in Area IV. Their specificity allowed an analysis of the effectiveness of separate displays in communicating information.

4. All interviews included background questions. These asked about socio-economic status, about prior training and interest in science, the circumstances surrounding the respondent's visit to the Science Pavilion, religious preference, age, sex, and residence.

5. Ideally, samples needed to be drawn entirely at random from the crowd flow. Three sources of sampling bias were analyzed; two of these were largely correctable in the field, while the third required stratified random sampling from already-collected interviews.

6. Administering the questions posed unique technical difficulties: the questionnaires were lengthy, their content threatening; distractions were many; items were difficult; respondents were usually busy and with little time. To overcome these handicaps, two novel interviewing techniques were adopted. The first used a rating scale on a thin metal board, with magnetic buttons as markers; the second made use of a "mechanical interviewer," an automated teaching machine with a branching program.

7. Besides the interviews, three subsidiary studies were conducted.

- A study of crowd flow patterns in Area IV of the Pavilion, using time-lapse cameras.
- A study of total Pavilion attendance over a week period, students counting entrants and departers.
- A study of reactions to the total Pavilion experience, people leaving the Pavilion answering several free-response questions.

CHAPTER II

MEASURING ATTITUDES TOWARDS SCIENCE AND SCIENTISTS

In beginning our exploration, there was no dearth of material. The growth of science is the key fact of the last three centuries; sensitive and intelligent men have devoted scholarly years to its explication. Our work began with reading.

But it soon became apparent, that most of what was written was tangential to our problem. Lectures on the scientific method there were in plenty: essays on operationism, wistful justifications of sociology as a science, paeans of praise to the creative imagination and the dignity of man. "Anti-intellectualism" was fought valiantly on the printed page; public ignorance was deplored. Yet there was relatively little material on public attitudes towards scientists or science. Several researchers had constructed scales to measure attitudes about science: these did no more than tell the strength of pro-or-con feelings. A few public polls had asked about specific issues. Such essayists as Sarton, Bronowski, and Snow presented rich, well-articulated attitudes towards science; but surveys of public attitudes were sparse, and simplistic in approach. Thus two needs struck us as paramount: to gain an insight into the public view of science and scientists; and to devise measuring instruments which tapped a number of attitude dimensions, allowing a rich sampling of opinion.

Interviewing for Insight

As a beginning, open-ended and free-ranging interviews were conducted with sixty people, chosen randomly but not systematically from Seattle residents (the Laundromat became our favorite hunting ground; people proved happy to be interviewed while waiting for the machines to disgorge).

Appendix I reports these interviews in an impressionistic fashion. In general, we were impressed that public understanding of science was greater than our reading had led us to expect. Nor were the negative stereotypes (the foolish absent-minded professor; the eccentric, irresponsible scientist) much in evidence. Science was seen as a good thing; scientists as useful and able people. Even the most religious saw no real conflict between Christian theology and science. Science was viewed primarily as a guardian and servant.

On the other hand, few people were able to give a clear and articulate picture of what science was about. Often the scientific method was spoken of as "breaking something down," separating things into parts or elements. The subject matter of science was in the public view limited to the "hard" disciplines; few people thought of psychologists, for instance, as scientists. Our general impression was not that the public was riddled with misinformation, but rather that public attitudes were marked by considerable good will and considerable vagueness.

Developing Attitude Questions

How to measure these vague, half-formulated opinions? By the nature of our task, we needed questions which could be asked of almost anyone, which were easily amenable to statistical analysis, and which covered much material in a brief time. The search for attitude items led us through several different questionnaires before we finally settled on the questions to be asked.

As a beginning, it seemed reasonable to approach our task by a variety of routes. Standard attitude scaling provided one tactic. We wrote a number of attitude scale items, often based on issues of concern to the scholarly world. For instance, C.P. Snow's notion of "The Two Cultures" found a pale reflection in such attitude statements as "The trouble with science is that it takes too much of the romance, beauty and interest out of life." Other questions asked about conflicts between science and religion, the role of science in public policy ("Scientists should have no more say in the government than any other citizen"), and the relationship of science to art. We hoped from these statements to derive a group of brief attitude scales which would meet Guttman criteria of scalability. Our initial collection of such attitude statements comprised twenty-three items.

A second route made use of Osgood's semantic differential technique. For this, the respondent is given a single concept and asked to rate it on a series of bipolar adjective scales.

Figure 2:1 shows several such adjective scales, as they might have been rated by an interviewee:

Figure 2:1

Bipolar Rating Scales

How would you rate the average scientist?

lazy	1 2 3 4 5 6 7	hard working
cautious	1 2 3 4 5 6 7	rash
youthful	1 2 3 4 5 6 7	mature
.		
.		
.		
eccentric	1 2 3 4 5 6 7	conventional

The Osgood technique seemed the most fruitful way of getting at the stereotypes of science and scientists in a large scale survey. It lends itself easily to statistical manipulation yet allows a fair diversity and range of response.

Fifty word pairs, similar to those shown in Figure 2:1 were chosen for the initial version of the questionnaire on "Scientists." Fifty others were chosen for the questionnaire on "Science." In general, we chose words which seemed relevant from our reading, or from comments made during the earlier interviews. Table 2:1 lists the initial word pairs used for describing scientists, Table 2:2 for describing science.

Seven questions in the preliminary questionnaire asked about the future implications of science: in subject they ranged from the automation of factory work to lunar exploration, from control of animal heredity to control of human behavior.

Table 2:1

Semantic Differential Items Used in the Initial Measurement of the Concept, "Scientist"

1. hard-working - lazy
2. rash - cautious
3. mature - youthful
4. serious - humorous
5. destructive - constructive

---

6. rational - intuitive
7. dishonest - honest
8. relaxed - tense
9. kind - cruel
10. patriotic - unpatriotic

---

11. polished - socially clumsy
12. insane - sane
13. optimistic - pessimistic
14. bad - good
15. friendly - unfriendly

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16. rugged - delicate
17. leisurely - hasty
18. proud - humble
19. likeable - unlikeable
20. incompetent - competent

---

21. cheerful - depressed
22. stupid - intelligent
23. sober - emotional
24. difficult to be with - comfortable to be with
25. well-paid - poorly paid

---

26. adventurous - timid
27. inconsistent - consistent
28. boring - interesting
29. has usual political views - has unusual political views
30. physically weak - physically strong

---

31. confident - unsure
32. selfish - unselfish
33. naive - sophisticated
34. active - passive
35. has unusual moral views - has usual moral views

---

36. imaginative - unimaginative
37. disloyal - loyal
38. calm - agitated
39. unoriginal - original
40. influential - uninfluential

---

41. outward-looking - inward-looking
42. has usual religious views - has unusual religious views
43. rigid - flexible
44. negative - positive
45. eccentric - conventional

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46. stable - changeable
47. unusual - usual
48. tender - tough
49. masculine - feminine
50. unwilling to make changes - willing to make changes

Table 2:2

Semantic Differential Items Used in the Initial Measurement of the Concept, "Science"

1. difficult - easy
2. shallow - deep
3. imperfect - perfect
4. comfortable - uncomfortable
5. meaningless - meaningful
6. moving - still
7. pure - impure
8. strong - weak
9. unpleasant - pleasant
10. intentional - unintentional
11. complex - simple
12. lasting - transient
13. eccentric - conventional
14. uncertain - certain
15. colorless - colorful
16. leading - following
17. consistent - inconsistent
18. inhuman - human
19. sophisticated - naive
20. new - old
21. motivated - aimless
22. unfriendly - friendly
23. incomplete - complete
24. kind - cruel
25. clean - dirty
26. worthless - valuable
27. peaceful - ferocious
28. intelligible - unintelligible
29. intuitive - rational
30. destructive - constructive
31. dissatisfying - satisfying
32. proud - humble
33. boring - interesting
34. youthful - mature
35. huge - tiny
36. clear - hazy
37. feminine - masculine
38. dangerous - safe
39. reliable - unreliable
40. cold - warm
41. partial - whole
42. good - bad
43. rough - smooth
44. harmful - helpful
45. humorous - serious
46. calm - excitable
47. effortless - laborious
48. ugly - beautiful
49. uninfluential - influential
50. attractive - repulsive

A sample--

> Do you think that science will ever be able to create life? How likely is it?
>
> very unlikely 1 2 3 4 5 6 7 very likely

Seven other questions gave seven definitions of science; the respondent was asked to pick the best, the next best, and so on. The definitions, while based on stereotypes encountered in reading and interviews, were phrased anew. I feel apologetic about them; they are not graceful, and any philosopher of science could object to them all as missing the quintessence of science. But it is not easy to ask about the philosophical quintessence of science in a public opinion poll, especially when we know that some respondents will have trouble reading more than simple newspaper text. The one definition which seemed to us most adequate was the following:

> Science is simply a method of finding out about things. The scientist tries to figure out how something happens; then he tests his ideas with further observations to see if they are right.

This may be contrasted with two other definitions, both of which turned out to be popular with the public:

> The scientist is anyone who is searching for truth. Any search for truth should be called a science.
>
> Scientists are people who break things down into parts and elements, in order to see how they fit together. Science is a keen analysis, an attempt to figure out important things by breaking problems down into parts.

Finally, the initial questionnaire listed eleven occupations; the respondent was to check the ones that were scientific in nature. The list ranged from astrologer to physicist, inquiring along the way about engineers, botanists, astronauts, cabalists, psychologists, etc.

Altogether, then, the initial attitude questionnaire contained 141 newly devised items. It also contained 36 other items, drawn from Eysenck's work on attitude dimensions.

Briefly, Eysenck had found that many specific opinions can be accounted for in terms of two general predispositions: a predisposition towards conservatism or radicalism, and a predisposition towards tough-mindedness or tender-mindedness. It occurred to us that attitudes towards science might also fit into these two dimensions. The possibility seemed worth exploring; therefore questions from scales of "Radicalism" and "Tough-mindedness" were included in the initial questionnaire.

The full questionnaire is given in Appendix II.

Analyzing Attitude Questions.

With such a multiplicity of questions, different methods of analysis were necessary. Some items were designed to go together into attitude scales, others to be tabulated and used as single ratings. Therefore the discussion which follows is divided into three sections. The first deals with the attempt to produce unidimensional attitude scales; the second considers findings from a preliminary factor analysis of semantic differential ratings, selected attitude items, and Eysenck's Radicalism and Tough-mindedness scale scores; the third section deals with items on the meaning and potentialities of scientific endeavor.

I. The attempt to produce unidimensional attitude scales: Our attitude items fell into three general content categories; it was hoped that they might make up three different scales. The first scale would concern the power appropriate to science, and the place of science in polity. The second would deal with the relationship between religion and science ("God's word is more important than anything the scientists might turn up in their studies"). The third would contain items of a generally favorable or unfavorable sort; it would measure positive or negative feelings about science. But before combining any items into a single scale with a single score, it was necessary to analyze their interrelationships, each with the other. Do all the items on science and religion, for instance, seem to be measuring the same thing? Are the items within the scale homogeneous? To answer these questions, Guttman's method of scalogram analysis was used.[1]

---

[1]Those unfamiliar with this particular technique may find the following description helpful.

Guttman scalogram analysis is a method for testing the "unidimensionality" of an attitude scale. A scale is referred to as "unidimensional" if (1) the scale items all measure substantially the same trait or attitude, and (2) each scale item reliably measures different amounts of that trait or attitude, over a fairly broad range. As can be seen, a scale may be homogeneous without being unidimensional, since the items may each measure the same trait but not vary in the amount of the trait implied. If a scale is unidimensional, however, it must also be homogeneous.

Guttman's method requires an examination of patterns of item response. If a scale is truly unidimensional, two people with the same scale score should have answered the specific scale items in much the same manner. But if the scale is not, then two people with the same score could have responded very differently to the specific items in the scale. For example, two people might both have high scores on a personality questionnaire, and yet have answered few of the scale items the same way. In such a case, we would conclude that the questionnaire was not unidimension.

(continued next page)

The attitude items were given to 150 college students taking Introductory Sociology at the University of Washington. We know of course that answers from this group will be different than those from the general population. But for our analysis it did not matter; here we were only interested in the way the questions related to each other. We felt that if the attitude scales turned out to be unidimensional when answered by college students, it was likely that they would also prove unidimensional when answered by the public, especially since the general public would probably have a greater response range.

Table 2:3 presents the results of the scalogram analysis.

Table 2:3

A Scalogram Analysis of Three Attitude Scales

Scale	Number of items	MMR	Rep
Perceived conflict of science and religion	5	.65	.72
Power appropriate to science..	6	.64	.68
General evaluation of science.	10	.84	.84

(Footnote continued)

Guttman has suggested several statistical indices for evaluating the unidimensionality of response patterns. The first index, the Coefficient of Reproducibility (Rep), tells how accurately one could predict the pattern of a subject's item responses by knowing his total scale score. The other index, the Minimum Marginal Reproducibility (MMR), tells how accurately one could predict the pattern of any subject's responses from knowing only the most frequent response pattern given by many subjects. A scale is unidimensional (and therefore homogeneous) if one would be relatively unsuccessful in predicting from the most frequent response pattern, but relatively successful in predicting from the total scale score. In other words, if the MMR is low, and the Rep is high, one has a relatively homogeneous scale.

None of the scales are acceptable in terms of the usual scalogram criteria. Dropping out the least satisfactory items still failed to produce scales adequate to our needs; this particular approach was therefore abandoned.

The work was not entirely wasted however. Some of the statements were intrinsically interesting in themselves, and received a wide range of answers. Later analysis also showed some to be homogeneous by factor analytic criteria. Four such items were retained for the final questionnaire, namely ....

> Science is so important to the world that scientists should have a strong voice in the government.
>
> Scientists should have no more say in the government than any other citizen.
>
> God's word is more important than anything the scientists might turn up in their studies.
>
> Individual scientists should take more responsibility for the way scientific discoveries are used.

II. The Factor Analyses of Semantic Differential Ratings: It will be recalled that the initial questionnaire contained 50 bipolar adjective rating scales for describing "Science," and 50 for describing "Scientists." These rating scales were filled out by the same 150 students who supplied the data for the scalogram analysis discussed above.

Once again, our purpose in collecting this material was not to find out how students felt about "Science" and "Scientists." Rather, we were interested in the relationship between the various adjective rating scales, and in the overall structure of attitudes. Although students were likely to differ from the general population in the content of their opinions, they were not apt to differ in their opinion structure.

Because of this, we felt relatively safe in factor analyzing the rating scales, and choosing for the final questionnaire those word pairs which gave the purest factor measures.

The above paragraph is probably meaningless to readers unfamiliar with factor analysis. The basic idea is relatively simple, however. We took 50 different ratings and analyzed the relationship of each rating to all the others. Then, making use of a mathematical technique known as "factor analysis", we discovered which rating scales appeared to belong together, i.e., which ones all seemed to measure a single underlying attribute. From this we were able to pick out those few rating scales which gave the "best" measure of that attribute (or, in more technical language, those which had high loadings in one factor and low loadings in all others). So when the analysis was finished, we emerged with fewer rating scales, but rating scales which seemed to measure much that the original 50 had measured. Osgood's earlier studies with the semantic differential indicate strongly that these are pretty much the same rating scales we would find if we collected our data from a sample of the general public, rather than from college students.

Ratings for the concept "Science" were factor analyzed by the principal axis method, and rotated to orthogonal simple structure by the method of analytic iterative rotation. As well as the 50 adjective rating scales, the following variables were included in the correlation matrix:

Scores on Radicalism-Conservatism Scale

Scores on the Tender-Tough Mindedness scale

Responses to the attitude statement, "There is really no basic conflict between science and religion."

Responses to attitude statement, "Science is not really to blame for the arms race."

Responses to the attitude statement, "God's word is more important than anything the scientists might turn up in their studies."

Ratings showing the amount of conflict between science and religion.

The analysis isolated eight factors, accounting for 51 per cent of the total variance. The full matrix of principal axis factor loadings is given in Appendix III, and of loadings after rotation in Appendix IV. A brief summary of the factors and the items which define them is provided by Table 2:4.

Items retained for the final questionnaire are marked with a "+" before them. All factors are represented in the final poll except for factor VIII. This, the "difficulty" factor, was excluded because it contained no item with a high factor loading, and only one item which did not have its major loading on another dimension. Its exclusion was perhaps justified on psychometric grounds, although as the project progressed, I came to regret the decision.

Much the same procedure was followed in analyzing items for the concept, "Scientist." These too were factored by the principal axis method and rotated to orthogonal simple structure. Besides the 50 semantic differential scales, the following scores were included in the analysis:

Scores on the Radicalism-Conservatism Scale

Scores on the Tender-Tough Mindedness Scale

Table 2:4

Factors and Marker Items

for the Concept "Science"

Factor Label*		Item	Loading**	h^2
I	Authoritarian-ism	+God's word is more important than anything the scientists might turn up in their studies	.97	.57
		Radicalism-Conservatism scale score	-.88	.41
		Rational-intuitive rating	.88	.37
		Tender-Tough mindedness scale score	.81	.41
II	General Evaluation	Colorful-colorless rating	-.96	.45
		+Constructive-destructive rating	-.93	.42
		+Good-bad rating	-.93	.61
		+Valuable-worthless rating...............	-.89	.52
		Friendly-unfriendly rating...............	-.88	.37
III	Progress	+Following-leading rating	.98	.63
		+Aimless-motivated rating	.95	.74
		+Unintelligible-intelligible rating	.94	.66
		Inconsistent-consistent rating	.88	.64
IV	Perfection	+Certain-uncertain rating	.92	.62
		+Perfect-imperfect rating	.92	.61
		+Complete-incomplete rating	.90	.55
V	Potency	+Youthful-mature rating	-.91	.43
		Rating showing the amount of conflict between science and religion	-.86	.19
		+Feminine-masculine rating	-.76	.48
		Uninfluential-influential rating	-.63	.62

Table 2:4 (Continued)

Factor Label*		Item	Loading**	h^2
VI	No Label	+Calm-excitable rating	-.89	.53
		Ugly-beautiful rating	-.67	.56
VII	Comfortable	+Cold-Warm rating	-.93	.47
		Rough-smooth rating	-.82	.59
		Dangerous-safe rating	-.69	.42
VIII	Difficulty	Unpleasant rating	-.61	.61
		Easy - difficult rating	.61	.40

* The factor labels listed here are, like all factor labels, tags of convenience. They represent the author's best guess as to the similarities between items having high loadings on that factor.

** These loadings are from the factor matrix after rotation to simple structure. They differ from the usual form, however, in showing the amount of common variance accounted for by that factor--ie, they are estimated on the assumption that the item communality is equal to 1.00. They are thus analogous to correlation coefficients after correction for attenuation. If the reader wishes, they are easily convertible to their raw form by making appropriate substitutions in the formula

$$\frac{(\text{Corrected loading})^2}{100} = \frac{x^2}{h^2}\text{, and solving for } x^2.$$

The value x gives the uncorrected loading.

Responses to the attitude statement, "Science is so important to the world that scientists should have a strong voice in the government."

Responses to the attitude statement, "Scientists should have no more say in the government than any other citizen."

Responses to the attitude statement, "Individual scientists should take more responsibility for the way scientific discoveries are used."

Ratings showing the amount of responsibility scientists should have in forming government policy.

Nine factors were isolated, accounting for 51 per cent of the total variance. The full matrix of principal axis factor loadings is given in Appendix V, the loading after rotation in Appendix VI. A brief summary of the factors, and their defining items, is presented in Table 2:5.

As before, all items retained for the final questionnaire are marked with a "+". Two factors had no items with a high enough loading to merit their use; these were accordingly dropped.

So far this discussion has been oriented around methodological problems. The need to develop scales for the main study was of course paramount in our thinking, and so governed our research. On the other hand, the results of these factor analyses have a certain interest in themselves, quite apart from their relevance to the Science Pavilion. Thus Eysenck's claim that attitudes are organized around two main dimensions--Radicalism and Tough-Mindedness--was not substantiated by our findings; instead both scales seemed to be measures of the same factor. The attitude dimensions found for "Scientists" have relevance to other problems, being particularly germaine to studies of stereotyping and social perception. Time pressures preclude a thorough

Table 2:5

Factors and Marker Items for the

Concept "Scientist"

Factor Label*	Item	Loading**	h^2
I General Evaluation	Insane - sane rating	.92	.49
	+Stupid - intelligent rating	.92	.74
	+Boring - interesting rating	.91	.68
	+Unoriginal - original rating	.90	.66
	Lazy - hard working rating	.88	.64
	Bad - good rating	.86	.65
II Neurotic Ineptitude	+Polished - socially clumsy rating	.96	.42
	+Calm-agitated rating	.90	.54
	+Relaxed - tense rating	.89	.48
	Cheerful - depressed rating	.78	.64
	Likeable - unlikeable rating	.78	.61
III Authoritarianism	+ Individual scientists should take more responsibility for the way scientific discoveries are used	-.88	.41
	Radicalism - Conservatism Scale score	.87	.31
	Intuitive - rational rating	.86	.39
	Tender-Tough Mindedness scale score	.73	.37
IV Public Responsibility	Scientists should have no more +say in the government than any other citizen	.92	.43
	Rating showing amount of responsibility scientists should have in forming government policy	-.87	.45
	Cautious -rash rating	-.68	.42
	Science is so important to the + world that scientists should have a strong voice in the government	-.66	.54
V Assertive Activity	+ Adventurous - timid rating	-.87	.63
	+ Active - passive rating	-.74	.55
	Stable - changeable rating	.72	.40
VI The Quiet Scholar Stereotype	+ Proud - humble rating	.84	.52
	+ Leisurely - hasty rating	-.71	.47
	+ Well paid - poorly paid rating	.61	.55

* (as in Table 2:4)
** (as in Table 2:4)

Table 2:5 (continued)

Factor Label*	Item	Loading**	h^2
VII Eccentricity	+Unusual - usual rating	.77	.62
	+Eccentric - conventional rating	.73	.51
	Influential - uninfluential rating	.68	.43
	Tender - tough rating.	.64	.35
VIII No label	Rugged - delicate rating	.50	.38
IX No label	Naive - sophisticated rating	.51	.50
	Imaginative - unimaginative rating	.49	.59

* (as in Table 2:4)
** (as in Table 2:4)

analysis of such leads; this must wait for the future.

In any event, the immediate needs were met. Thirteen word pairs had been extracted for rating "Science," thirteen for rating "Scientists." A few attitude statements were also found to provide important data and were retained.

III <u>Analyzing the meaning and potentialities of science</u>: For two other groups of questions, analysis was less complex. These comprised seven statements which the respondent was to rank, on the definition of science; and a list of professions, the respondent indicating which ones were scientific. The distribution of responses was analyzed; we wished to make sure that no items were so obvious that everybody agreed in their answers. One definition of science was dropped since it received universally low endorsement. Table 2:6 shows the items retained.

Table 2:6

Definitions of Science

Used in Final Attitude Survey

And Mean Rank Assigned by 150 Students

Definition	Mean Rank
Science is simply a matter of logical thinking. The scientist tries to figure out problems in a logical way.	4
Science is simply a method of finding out about things. The scientist tries to figure out how something happens; then he tests his ideas with further observations to see if they are right.	1
Science is an organized collection of facts. The scientist's job is to collect facts on various problems.	6
Scientists are people who break things down into parts and elements, in order to see how they fit together. Science is a keen analysis, an attempt to figure out important things by breaking problems down into parts.	2
The scientist is anyone who is searching for truth. Any search for truth should be called a science.	3
Science is simply an attempt to make the world a better place by discovering new inventions and facts. The scientist is a person who attempts to produce better things for better living.	5

Table 2:7

The Potentials of Science:

Final Questionnaire Items and Mean Student Responses

Item	Very unlikely → Very likely	Mean Rating
Do you think that man will have landed on the moon by 1980? How likely is it?	1 2 3 4 5 6 7	6.13
Do you think that science will ever understand so much about human beings that crime and poverty can be eliminated? How likely is it?.................	1 2 3 4 5 6 7	3.26
How likely is it that scientists will be able to create new species of animals by changing heredity? ..	1 2 3 4 5 6 7	5.34
Do you think that science will ever be able to predict and control the behavior of individual people? How likely is it?	1 2 3 4 5 6 7	4.06
Do you think that science will ever be able to create life? How likely is it?	1 2 3 4 5 6 7	3.90

From the list of eleven professions, four occupational titles were retained. They were, (1) An electronics engineer, (2) A physician, (3) A physicist, and (4) A psychologist. Their inclusion was entirely on rational grounds. Both the electronics engineer and the physician apply their knowledge to practical problems. Given the pavilion's emphasis on "pure" science, we might expect some change to occur in the frequency with which applied occupations were seen as scientific. In several sections of the pavilion the study of human and animal behavior was presented as a branch of science; perhaps as a result the psychologist might come to be seen as more scientific. The physicist category was retained solely because we felt that respondents might find the task pleasanter with one inarguable case.

A final group of questions asked about the future and the likelihood of specific advances. Two of these were dropped from the final questionnaire, our guinea-pig students complaining that the statements were unclear or ambiguous. The retained items are presented in Table 2:7.

Altogether, then, the final questionnaire contained 45 items. Further pretesting on the fair grounds indicated that ten to fifteen minutes sufficed for its administration. All items seemed easy enough to answer, with the exception of the six definitions. Resistance to them was not so great, however, as to force their discontinuation. The final questionnaire is given in Appendix VII.

<u>In Brief</u>:

1. Prior to developing attitude scales, open-ended interviews on science and related topics were held with 60 Seattle residents. Attitudes were generally favorable, but vague.

2. Several techniques of attitude measurement, covering a wide range of content, were pretested on a sample of 150 college students. The respondents described science and scientists on bipolar adjective scales, ranked definitions of science, evaluated the future implications of scientific research, told which of eleven occupations were scientific in nature, and responded to 23 attitude statements. The latter were designed to assess three variables: (1) Perceived conflict between science and religion, (2) Power appropriate to science, and (3) General evaluation of science. Also included were most of the items in Eysenck's Tender-Tough Mindedness scale and Radicalism-Conservatism scale.

3. A factor analysis of 50 adjective ratings for the concept "Science" isolated eight factors; these were labeled as follows:

- Authoritarianism
- General evaluation
- Progress
- Perfection
- Potency
- (No label assigned)
- Comfortable
- Difficulty

Thirteen adjective scales, those with highest and purest loadings on seven of the above factors, were retained for the final questionnaire.

4. A factor analysis of 50 adjective ratings for the concept, "Scientist," isolated nine factors, the last two being indeterminant in nature. The seven most clear are here listed:

- General evaluation
- Neurotic ineptitude
- Authoritarianism
- Public responsibility
- Assertive activity
- The quiet scholar stereotype
- Eccentricity

Thirteen adjective scales were retained as measures of these seven factors.

5. A scalogram analysis of 23 attitude statements gave negative results; the items failed to meet acceptable standards of unidimensionality. However, four of the items were retained because of their intrinsic importance and because they were found to provide relatively pure factor measures in the factor analysis cited above.

6. Opinion questions about the potentialities of science were pretested; two of the seven were dropped because of ambiguity or lack of clarity.

7. Six definitions of science were retained for the final questionnaire. The key concepts of each are listed below:

- Science is logical thinking
- Science is a method of investigation.
- Science is a collection of facts.
- Science is any search for truth.
- Science is a breaking of things into parts to see how they go together.
- Science is an attempt to produce better things for better living.

8. Four occupational titles--electronics engineer, physicist, psychologist, physician--were retained to see which were regarded as "scientific."

9. The final attitude questionnaire consisted of 45 items taking 10 to 15 minutes for completion.

CHAPTER III

MEASURING INFORMATION RETENTION

The sheer volume of information contained in the Science Pavilion exhibits was immense; immense, too, would be the task of polling every bit of it. Only by restricting our attention to one specific Pavilion area, and by asking a relatively small number of questions, would a survey be possible. The area chosen for studying information retention was Hall IV, devoted to "The Methods of Science." From a much larger pool of possible questions, 104 were chosen. The criteria governing these choices are described in the present chapter. But before discussing problems of item selection in detail, let us first look at certain other issues relevant to information retention.

The exhibits in Hall IV were varied and complex; few people viewed them all. It thus was necessary to find out which exhibits the respondent had particularly noted and liked. If information increased at all, we would expect it to increase mostly in response to the liked exhibits. So questions about exhibit preference were included in the interview.

In addition, we had a hunch that people who already were knowledgeable about science would retain more information. To test this, a subsample of interviews was preceded by a general science scale, using questions originally standardized in a test from Acorn Publishing

Company. Besides these test scores, we also asked the usual background questions of all respondents.

Other questions occurred to us also. It will be recalled that time-lapse movies recorded patterns of crowd flow in Hall IV; these movies allow a separate analysis of relationships between frequency-of-viewing and information retention. Further, it is possible to look at the displays themselves, and see what things about an exhibit are most attractive to the viewers and/or seem to communicate the most information.

These separate and complex analyses of the data largely remain to be done, although some preliminary data are reported in Chapter IX. But here, and in Chapter VII, we shall report the work accomplished to date: the development of information questionnaires, and the overall findings on information retention.

Choosing Information Items

When we began our work, the specific displays in the Science Pavilion had not been constructed; we had only the haziest notion of their final form. We did, however, have preliminary copies of the explanatory text accompanying each exhibit. From these texts the information questions were developed.

The initial step was a content analysis, the information in each text being abstracted. From this content analysis, a pool of 419 tentative multiple choice questions was developed.

Some examples:

The center of the retina of the eye is called
1. the fovea
2. the pupil
3. the cornea
4. the extophelia

In some cases, NGF may stimulate the growth of
1. central ganglia
2. sensory ganglia
3. peripheral ganglia
4. parasympathetic ganglia

Scientists learn about the nucleus within the atom by
1. electron bombardment
2. microscopic examination
3. radio wave concentrations
4. studying the solar system

The tiny atom is
1. invisible
2. visible to the naked eye
3. visible, but only with a microscope
4. visible, but only to scientists

As these samples make clear, the questions ranged from the simple to the abstruse. Note too that some might be answered correctly on the basis of common sense, or skill at guessing, rather than from actual knowledge. Needed was a final group of items which were neither too simple nor too complex, and which measured real knowledge rather than the ability to guess correctly. Further, we wanted to be sure that our items were drawn from displays in all parts of the exhibit hall, and covered all the field of science shown.

As a start, we grouped specific displays by field. Table 3:1 lists the various displays, grouped into eight general content categories. Each of the eight categories needed to be sampled with appropriate questions.

Table 3:1

Specific Displays in Hall IV, Arranged by General Content Categories

1. General Biology:

   The cell
   Cell reproduction
   DNA
   Virus

2. Human Physiology:

   The central nervous system
   Nerve growth factor
   Eye structure
   Muscles

3. Botany:

   Phytochrome
   Plant growth

4. Behavioral Sciences:

   Imprinting
   Maternal affection and monkey behavior

5. Nuclear Physics:

   The atom
   Structure of the nucleus
   Cloud chamber and cosmic rays

6. Macrophysics:

   Astronomy
   Radio astronomy
   Auroras
   The sun

7. Applied Physics:

   Fuel cells and electricity
   Artificial diamonds
   Ultracentrifuge
   Satellite tracking station

8. Geology:

   Inside the earth

In our item selection we tried to meet the following criteria:

1. Questions sampling any particular content category should range from easy to hard. Too many easy items would result in a scale insensitive to the thorough learner, too many hard items would cause respondent dissatisfaction.[1]

2. Each main display should be represented in the item selection.

3. The items should not be redundant.

4. Items should be true measures of information, rather than measures of guessing skill.

5. Items should be homogeneous enough to allow their combination in a single test score, in case we wished to make comparisons between general content categories.

To meet these criteria, each of the 419 questions had to be examined to find its difficulty level, i.e., how often the correct answer was endorsed. Repetitious items had to be weeded out. Each question had to be examined by a knowledgeable scientist to eliminate factual errors. And, finally, every item had to meet certain other standards if it was to be regarded as a true measure of information, rather than as a measure of guessing skill.

To begin with, eight separate groups of questions were mimeographed. Each group covered one of the general content categories listed in Table 3:1. The number of items varied from group to group; thus, 104 questions were included for general biology, but only 13 for botany. The full questionnaire is given in Appendix VIII.

[1] In our original planning we anticipated that each scale might start off with easy items, and continue through more difficult ones. If the final scales met certain scaling standards, we could discontinue questionning when the respondent was obviously out of his depth. This plan proved impractical, however, since some of the interviewing was done with teaching machines, and these did not have the requisite branching capacity.

Each group of items was then given to a sample of fifty college students. A total of 250 students served as subjects. Responses to every question were tabulated, giving a measure of item difficulty.

How to evaluate whether the item was a true measure of knowledge, rather than a measure of guessing skill? With a large group of questions, it seemed to us reasonable that people who answered the majority of questions correctly would be people with the greatest knowledge. In other words, we might think of all items in the group as comprising a crude sort of test. In general, the people with high scores in that test would be the most knowledgeable. And if this were so, then the items which best measured knowledge would be most often answered correctly by the people who made high scores in the test. On the other hand, poor items (those which measured guessing-skill or were ambiguous and misleading) would not discriminate as well between people with high and low test scores.

One might argue, of course, that people who achieved high scores might have done so by their guessing skill; and that items which discriminated high and low scorers were questions which were easiest to guess. But we had tried hard to eliminate extraneous cues when we prepared the original questions, so it seemed likely that the final score was mainly a knowledge measure.

Following the logic outlined above, each student was assigned a total scale score: consisting of the number of right answers given to all items. Then each group of fifty students was divided into two halves; those who had scored high and those who had scored low. To find out how well any particular question discriminated between the two groups, we found the percentage of low-scoring people who answered it correctly, and compared this with the percentage who answered correctly in the high-scoring group. The relationship between each group and the percentage of right answers for any particular item was evaluated with the tetrachoric coefficient of correlation. In Appendix IX. the results of these data analyses are given. A test made up of items with high coefficients should be little affected by guessing, and should be homogeneous enough to allow a meaningful total score.

Thus two criteria entered into the initial item selection: the items should range widely in difficulty, and they should have tetrachoric coefficients above the group median.

Items in each series were rank-ordered with respect to the percentage answering the item correctly; and the ranks divided into four subgroups. Equal numbers of items were chosen from each subgroup whenever possible. Those items having the highest tetrachoric coefficients were retained for further analysis.

The candidate items were next examined to find which ones covered the largest number of exhibits. Redundant questions were eliminated. Each item was evaluated either by a biologist, a physicist, or a psychologist, to make sure that no factual errors had crept in.[1]

As a final check, we then visited Hall IV--by this time in operation--to see if the candidate items were still on exhibit, and to guard against vocabulary changes.

With three exceptions, all eight scales resulted in 16-item tests. The three shorter tests were those on Behavioral Science (12 items),

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[1] We wish to express our appreciation to Oscar Sander and Philip Loe for their help on this task.

Botany (6 items) and Geology (6 items).

The scales, in their final form, are shown in Appendix X.

<u>In Brief</u>:

1. Studies of information retention were limited to a single hall of the Science Pavilion: Hall IV. This area was devoted to "The Methods of Science," and contained exhibits differing widely in subject matter and in display technique.

2. Four-hundred and nineteen information items were drawn from display texts, and multiple-choice questions composed.

3. As a preliminary step, the exhibits and the questions were categorized under eight headings: viz,

- General Biology
- Human Physiology
- Botany
- Behavioral Sciences
- Nuclear Physics
- Macrophysics
- Applied Physics
- Geology

4. Candidate information questions were given to 250 college students. Using these preliminary data, each item was evaluated on several criteria:

- Difficulty level of the item.
- Sampling adequacy of the item (i.e., was it drawn from a display whose content was untapped by other items?).
- Discriminating power of the item, as given by the tetrachoric coefficient.
- Factual accuracy, and lack of overlap with other items.

Those most satisfactory were retained for the final questionnaires.

5. The final information measures consisted of eight different scales, the majority containing sixteen multiple choice items.

CHAPTER IV

MEASURING BACKGROUND CHARACTERISTICS

It is unlikely that the Seattle Fair attracted a representative sample of U.S. citizens; it is even less likely that the Science Pavilion drew equally from all socio-economic strata. What kinds of people viewed the exhibits? And were different types of people affected in different ways by the Pavilion? To answer these questions in any detail, a goodly number of background questions needed to be asked. This chapter describes the items chosen to make up the background questionnaire.

Three general topics were probed: the socio-economic background of the respondent, his specific contact with science in school and the circumstances of his visit to the Pavilion. The specific questions for each topic are described below.

Measures of socio-economic background:

Under this heading are included a variety of census-type questions, as well as other questions which have been found pertinent to political and social attitudes. The respondent was asked about his occupation, his income level, his education, his religious preference, his age, and his marital status. He was asked to tell whether he thought of himself as "being in the upper class, upper-middle, middle, lower-middle, or lower class." Place and length of residence were probed. The respondent's sex was noted by the interviewer. The specific questions are shown in Table 4:1.

Table 4:1

Specific Background Questions:

Socio-Economic Variables

Occupation

What kind of work do you do?

____

(Occupations such as 10th grade teacher, TV repairs, truckdriver, retired, housewife, student, unemployed, unable to work, etc.)

What kind of business or industry do you work in?

____

(City high school, radio & TV service, construction, etc.)

Class of worker: (Circle Code)

For government..........	1
For private employer....	2
In own business.........	3

Education

(Circle Code)

Some grade school.............	1
Completed grade school........	2
Some high school..............	3
Completed high school.........	4
Some college..................	5
Completed college.............	6
Some graduate work............	7
Completed advanced degree.....	8

Income

What is the broad income group in which your total family income for 1961 fell? (Family income includes all income of all relatives living in the household.)

(Circle code)

Under $1,000...........	01
1,000 - 1,999..........	02
2,000 - 2,999..........	03
3,000 - 3,999..........	04
4,000 - 4,999..........	05
5,000 - 5,999..........	06
6,000 - 6,999..........	07
7,000 - 7,999..........	08
8,000 - 8,999..........	09
9,000 - 9,999..........	10
10,000 - 14,999........	11
15,000 - 24,999........	12
25,000 - and over.......	13

Age

What is the month and year of your birth?

____

(Month) (Year) Office code

Table 4:1 (Continued)

Residence

Where is your home located?

____

(City) (State)

Do you live in- (Circle code)

A city..................	1
A suburban area.........	2
A rural area............	3

When did you move into your current home?

(Circle code)

1962....................	1
1961....................	2
1960....................	3
1959....................	4
1958 or earlier.........	5

Other:

Sex: (Circle code)

Male...............	1
Female.............	2

Marital Status: (Circle code)

Married................	1
Widowed................	2
Divorced...............	3
Separated..............	4
Never married..........	5

Religion

What is your religious preference?

(Circle code)

Protestant...........	1
Catholic.............	2
Jewish...............	3
Other................	4
No preference........	5

About how often do you attend religious services?

(Circle code)

More than once a week.......	1
Once a week.................	2
Two or three times a month..	3
Once a month................	4
A few times a year or less..	5
Never.......................	6

Class Status Self-Description

Which of these groups do you consider yourself a member of? By and large do you think of yourself as being in the upper class, the upper-middle, the middle, the lower-middle, or the lower class?

(Circle code)

Upper class.................	1
Upper-middle................	2
Middle......................	3
Lower-middle................	4
Lower class.................	5

As in the other sections of the interview, most of these questions were pre-coded, to minimize the complexities of later data processing. But a few items needed more detailed treatment. Thus codes for the 50 states were assigned later, and a special analysis of Washington State made. The occupation questions were also coded after the interview was finished, using the major categories developed by the U. S. Census. (Whenever possible, the precoded questions were written so as to be comparable with census figures also).

Measures of Science Training and Interest

Among the things which influence attitudes towards science, one would expect to find the respondent's previous training in science to be high on the list. Two questions measuring this were asked. A third question inquired about over-all interest in science. Table 4:2 shows the specific items.

As a gross over-all measure of science background, the total number of science topics taken in high school, and again in college was computed.

The Circumstances of the Pavilion Visit

Another group of questions were included because we had a hunch that transient social factors influenced responses to the exhibits. If one is shepherding a group of children, the fair-going experience is different than if one is alone. And if specific things have been recommended, the advice is likely to influence what is seen and remembered. To assess these variables, the questions shown in Table 4:3 were asked.

Table 4:2

Did you take any of these subjects in high school?

		(Circle codes) Yes	No
32	General Science	1	2
33	Biology	1	2
34	Chemistry	1	2
35	Physics	1	2
36	Psychology	1	2
37	Sociology	1	2
38	Anthropology	1	2

Did you take any of these subjects in college?

		(Circle codes) Yes	No
40	General Science	1	2
41	Biology	1	2
42	Chemistry	1	2
43	Physics	1	2
44	Psychology	1	2
45	Sociology	1	2
46	Anthropology	1	2

53 In general, how interested in science are you?

Not interested (Circle code) ⟶ Very interested

1 2 3 4 5 6 7

Table 4:3

Specific Background Questions:

Circumstances of the Pavilion Visit

How many people came with you today? ....

How many adults? ....

How many children? ....

Sometimes what people see at a fair depends on what kind of people they came to the fair with -- How did you come today?

(Circle code)

Alone.....................	1
With a group tour.........	2
With your family	3
With guests	4

About how many times have you visited the Science Pavilion?

(Circle code)

This is my first visit	1
Only once before	2
Twice before	3
Three times before	4
Four or more times before ..	5

Did you hear anything about the Science Pavilion before you came to see it the first time?

(Circle code)

Yes	1
No	2

What parts of the Pavilion were recommended to you?

Were there any parts of the Science Pavilion you were told not to bother to see? If yes, what parts?

A final question asked the respondent what parts of the Science Pavilion he would recommend to others. The full questionnaire is given in Appendix XI.

Interviewing on Background Characteristics

The questions reviewed above were asked of each person contacted, whether the interview itself concerned attitudes or information retention. The circumstances of the asking varied with the interview. In some cases, the respondent filled out the form himself, and his answers were reviewed with him by the interviewer. When interviewing was conducted by the Autotutor, part of the background information was gathered in a face-to-face interview, the rest by the machine. It is likely that these different techniques produced different biases in our data; this possibility has not as yet been analyzed.

In Brief:

1. Background questions were asked to discover the kinds of people most attracted to the Science Exhibit, and to see whether different groups had different reactions to the displays.

2. A number of socio-economic variables were tapped--occupation, education, income, class-identification, residence, religion, etc. When appropriate, answers to these questions were coded so as to allow comparison with census data.

3. Questions about previous training in science were included.

4. On the assumption that transient social pressures and the circumstances of the pavilion visit influenced response, questions probing these areas were also asked.

5. The above background data was collected from all respondents, both in the attitude and in the information interviews.

CHAPTER V

INTERVIEWING TECHNIQUES, SAMPLING, AND SAMPLE CHARACTERISTICS

Interviewing at a fair differs greatly from the more usual house-to-house survey, posing unique problems and demanding unique solutions. In an ordinary poll the interviewer goes from one dwelling to another, each dwelling previously selected so as to provide a random but representative sample of households. Relatively few people refuse to be interviewed. The situation at a fair is not so simple. People stream past an interviewer, intent on making the most of their limited time. Usually they are accompanied by family, all eager to be on their way. Refusal rates are high, so one can never be sure of having a representative population. Again, a fair will attract different groups at different times: the evening crowd is likely to differ systematically from a morning crowd, and the people who come in the middle of summer will not be like those who come in late fall. All these factors militate against the drawing of a representative sample.

Given such problems, there are several things that a survey researcher can do. He can make the interviews as interesting and attractive as possible, to cut down refusal rate. He can draw his sample during different periods of the day, and at different periods of the Fair. He can reduce interviewer bias by making subject selection completely mechanical.

This chapter details the interviewing techniques adopted for use at the Fair. Sampling problems are discussed, and the background characteristics of the sample reported. The implications of sampling bias are discussed, along with their relevance to the problems we set out to study.

Interviewing Techniques

In order to make the interviews attractive to respondents, and to eliminate time lag in handling interview materials, several novel interviewing techniques were devised.

Much use was made of a "magnetic board" device, both in collecting attitude and in collecting information data. The device itself was simple. A mimeographed sheet with questions was pasted onto a thin metal board. The respondent answered each question by marking his reply with a small plastic button, in which was imbedded a magnet. The answers were recorded by the interviewer. The magnetic markers appeared to exert a kind of fascination; people enjoyed playing with them and watching them cling to the paper. Figure 5:1 shows the boards and their use in the interview setting.

A more complex technique was adopted for some of the information interviews. We had feared that people might object to taking "tests" about science with an interviewer watching; it is no fun to expose ignorance to a stranger. Cooperation might increase, we felt, if the questions were asked in a purely impersonal manner--i.e., by machine. We anticipated that a machine-interviewer would have other advantages as well: it should, for instance, cut down interviewing costs by allowing several ongoing interviews to be conducted by a single human being who routed respondents to the machine. And the very novelty of the machine should prove attractive in its own right. Needed was a device which would present a question with several multiple choice answers, record the answer chosen, and go on to the next question.

Used was the Mark II Autotutor, a product of U. S. Industries, Incorporated, coupled to a Baranoff Printing Recorder. The autotutor is designed to select and project

> ...single 35 mm filmed images prepared for individual student training. It is basically an automatic, semi-random access film projector with a rear projection screen. Each reel of film stores 1,500 to 3,000 frames of instructional material, depending on the type of film used. Reels can be easily changed.
>
> Response buttons...To the right of the viewing screen is a row of nine selector buttons and one return button. After a lesson or a problem solving situation has been selected by a supervisor, the student progresses through the material by selecting a response to the question on each frame and pressing the button indicated. The Mark II immediately presents the student with the image corresponding to the button he pressed.[1]

Figure 5:2 shows the Autotutor as set up for operation at the fair.

Within the Autotutor was a 35 mm film, containing two (or sometimes three) information subjects, along with certain background questions. Machine interviews at the end of Hall IV had, in addition, questions on exhibit preference. Each film was introduced by a cartoon figure, "Otto the Autotutor," who explained the machine and its operation (see Figure 5:3).

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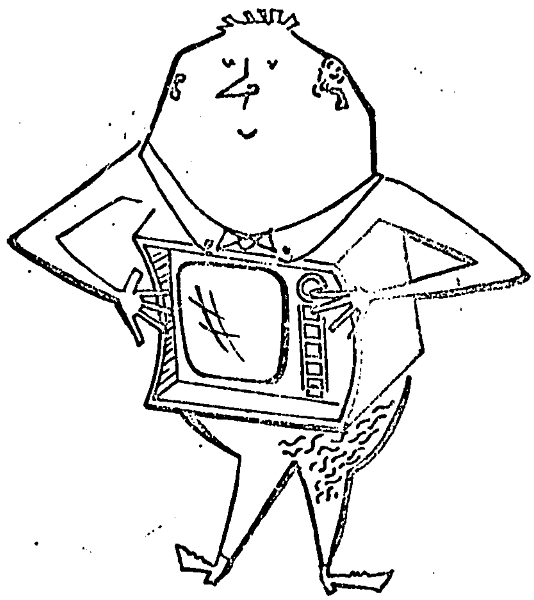
1. Quoted from a brochure supplied by U.S. Industries

Hi!
I'm an Autotutor -
Call me "Otto" - for short.



Today I am being used as a mechanical interviewer...
But you'll see that I have a personality as well....

I'm going to ask you some questions, and after each question I want you to push one of my buttons. Every now and then you will give me so much information that I will have to record it--sort of "clear my mind." You'll see how this is done later.

Let's try a sample question so you can see how I work. For example, please answer the following:

What is the shape of the earth?

Round	Push button A
Flat	Push button B
Square	Push button C

Now go ahead - Push the button you think is correct.

Sample Frame From Teaching Machine Program

Figure 5:3

There were too many information questions for any one respondent to answer them all. Instead, each individual was given two or three subtests. Certain interviews included only one subtest, in conjunction with the Acorn test of General Science Information. The particular subtests were varied among interviews, in order to randomize whatever interaction effects existed. Thus 14 different types of information questionnaires were given to people about to enter Hall IV; fourteen others were given to people who were leaving Hall IV.

Altogether, 1480 interviews were collected using the teaching machine, and 2602 in face-to-face interviews. For attitude interviews, people were interviewed in each of the six sampling areas, giving altogether 5198 completed attitude questionnaires.

Initially, it was assumed that all of the information questionnaires would be collected with the Autotutor. The Baranoff recording devices, however, proved less reliable than we had hoped, seldom operating more than a day without malfunction. The costs of equipment maintenance and repair proved prohibitive; as a result, machine interviewing was discontinued after eight weeks.

The setting of the interviews varied as we became more accustomed to the unique interviewing situation. The following procedure proved the most workable--

At the beginning of the shifts, the interview crews would set up tables and chairs at the sampling site. A rope partition surrounded the interviewing area; outside, a sign was placed which read: "SCIENCE IN ACTION. THIS IS A SCIENCE OPINION POLL STUDYING THE SCIENCE PAVILION. THE METHOD USED IS RANDOM SAMPLING. SORRY, NO VOLUNTEERS."

Usually one member of the crew acted as a "spotter." Just before an interview was finished, the interviewer would signal the spotter. The spotter then would go to the sampling grid (for a discussion of sampling procedures, see below). A new respondent being selected, the spotter would approach and request cooperation "with a study of the Science Pavilion being carried on by the University of Washington." The specific wording varied from time to time and from spotter to spotter; an attempt to standardize it quickly came to sound rehearsed and routine. Sometimes much persuasion and explanation was necessary. It was soon discovered that some spotters were more effective than others; the best results seemed to come from a self-confident person who clearly *expected* the respondent to cooperate.

Although the above procedure was the most usual one, there were occasions when the interviewer would serve as his own spotter, especially when only a few people were working at an interview area.

Sampling Methods for Attitude Interviews

Some of the problems of sampling fairgoers have been outlined in the earlier pages of this chapter. It will be recalled that the Science Pavilion population might be expected to differ systematically by the area sampled, the time of day, the day of the week, and the particular month. Further, those who refused to be interviewed might differ systematically from their more cooperative fellows.

What would be needed in order to get a truly *representative* sample of pavilion viewers? (By "representative" we mean that each person who entered the Pavilion would have an equal chance of being interviewed.)

In the first place, it would be necessary to draw interviews in proportion to the crowd flow, more interviews being drawn when the crowd was thick, fewer when it was thin. Secondly, a sample would not be really representative if many people refused to be interviewed. Thirdly, the interviews should be proportionally spaced throughout the fair period, proportionally taken throughout the week and during each day. And finally, interviewer bias should be totally eliminated.

With our resources, it was impossible to get a representative sample of people. Interview crews could not be hired to cover the full day in each sampling area. Nor had we any way of knowing how many people had entered the pavilion in order to draw a proportional sample. Too, our refusal rate was relatively high: on the average, 29.2% of those contacted either would not be interviewed or else terminated before completion. Interviewer bias could be largely eliminated by making participant selection into a routine, mechanical task, but even so there was sometimes room for choice.

We could, however, draw a comparable sample.

Most of the questions that we asked did not require that each person who came to the Pavilion have an equal chance of being interviewed. We were mainly interested in before-and-after comparisons of viewers. For this, we needed only to be sure that each before-and-after sample was drawn in a comparable way. Such biases as existed in the sample had to be equally biasing in each interview area. We had to make sure, for instance, that each before-and-after sample contained people with roughly the same educational background; that more women were not present in some samples than in others, and so on.

The interview teams were assigned so that approximately the same number of people were interviewed during the morning in one area as in another. We tried to balance the interviews so that each day of the week was equally represented in each sample, and that each month gave a comparable group of interviews.

Still another source of error was minimized by making the selection of respondents into an automatic and mechanical process. People to be interviewed were drawn from a clearly demarcated area of the floor--one of several sampling areas set up in a grid near the interviewing station. When the interview team needed a subject, the "spotter" would stand beside the grid. The first person to enter the sampling area would be approached. We early discovered that some overly-cooperative people--anxious to be interviewed--would watch the interview team, discover that respondents were being picked from a single spot, and then wander past at the appropriate time. Such sub rosa volunteers would have badly biased the sample, so several grid areas were set up near each interviewing station. Respondents were picked from the sampling areas in rotation.

Table 5:1 presents the data on attitude interviews collected at various spots in the Pavilion. The figures for time of day, day of week, and month, are roughly similar, especially when it is realized that people were apt to enter the first part of the Pavilion earlier and leave the last part later. Still, our interviews are not as comparable as we might wish, and this lack of comparability shows up in the type of respondents drawn in each area. As Table 5:2 makes clear, there were sometimes large differences in the backgrounds of people sampled at different interviewing sites. The complete tabulations are shown in Appendix XII.

Table 5:1

Attitude Interview Characteristics:

Original Sample

Time of Day	Per Cent of Interviews, by Sampling Area					
	I	II	III	IV	V	VI
9:30-11:29	8.5	9.6	8.5	8.9	6.0	5.7
11:30- 1:29	12.4	17.7	18.0	18.9	13.7	14.9
1:30- 3:29	26.2	19.5	22.6	21.0	20.4	22.5
3:30- 5:29	33.1	16.3	22.7	26.4	27.5	25.6
5:30- 7:29	14.3	22.4	19.2	16.5	21.5	19.5
7:30- 9:30	5.5	14.5	8.9	8.2	10.8	11.8
N	866	866	866	866	868	866
Day of Week	I	II	III	IV	V	VI
Monday	17.3	8.8	14.0	8.5	10.3	9.2
Tuesday	22.3	10.5	9.1	14.2	13.4	6.5
Wednesday	10.7	7.6	16.1	12.7	16.2	17.7
Thursday	7.3	14.0	14.5	27.6	16.4	19.4
Friday	8.8	30.8	14.0	10.9	18.2	18.1
Saturday	17.8	17.1	16.5	18.1	9.9	15.7
Sunday	15.8	11.2	15.8	8.0	15.7	13.4
Month	I	II	III	IV	V	VI
June	2.1			0.7		2.2
July	11.9	27.7	27.1	5.8	8.9	7.2
August	38.7	22.5	26.8	46.0	30.5	41.5
September	28.4	34.9	32.4	31.1	26.7	23.2
October	18.9	14.9	13.6	16.5	33.9	26.0
Non Respondents	I	II	III	IV	V	VI
(Per cent of total contacts)	24.8	26.4	27.6	24.9	35.3	33.1

Table 5:2

Background Characteristics of

Attitude Respondents: Original Sample

Age	Per Cent of Respondents, by Interview Area						1960 Census Washington State[1]
	I	II	III	IV	V	VI	
14-19	14.2	13.8	16.6	9.4	17.2	15.0	10.7
20-24	11.1	14.6	16.9	8.7	14.0	17.9	8.9
25-29	10.7	12.8	10.8	7.0	11.2	11.6	8.6
30-34	8.4	7.3	8.2	9.5	8.3	9.7	9.4
35-39	11.1	11.1	11.0	16.8	11.9	10.9	10.3
40-44	11.3	12.3	10.2	17.2	9.8	11.8	9.7
45-49	9.2	9.7	7.8	13.4	8.8	7.6	8.9
50-54	8.0	8.8	6.1	8.4	8.0	5.4	7.8
55 or over	16.1	9.6	12.3	9.5	10.9	10.0	25.7
Median Age Group	35-39	35-39	30-34	35-39	30-34	30-34	40-44

Education	I	II	III	IV	V	VI
Some grade school	.2	.1	.2	.6	.5	.2
Completed grade school	4.4	3.0	1.7	2.3	3.5	2.8
Some high school	15.0	11.1	14.0	10.1	14.1	12.5
Completed high school	23.7	20.2	20.1	23.9	20.7	20.4
Some college	26.8	29.2	30.2	29.7	28.7	30.4
Completed college	12.4	13.5	12.8	14.1	12.7	14.5
Some graduate school	10.2	12.1	11.0	9.6	8.8	10.2
Holds advanced degree	7.4	10.7	9.9	9.7	11.2	9.0

1. Census figures for age, occupation, and income are taken from Final Report PC(1)-49C, U.S. Census of Population: 1960. The census percentages are weighted to conform to the different population base used in the present study. Census figures for education are not given, since proportional weighting was not possible.

Table 5:2 (continued)

Occupation	I	II	III	IV	V	VI	Mean	Census
Professional and technical	22.1	29.4	27.9	28.9	27.3	28.1	27.3	6.9
Farmers and farm managers	2.0	.9	1.5	1.6	1.3	2.0	1.6	2.2
Managers, officials, proprietors	12.0	10.4	10.9	11.8	9.6	8.4	10.5	6.8
Clerical	8.9	8.1	8.2	7.8	7.7	8.1	8.1	3.4
Sales	3.3	3.0	3.1	2.4	3.6	3.3	3.1	4.0
Craftsmen and foremen	6.1	5.7	6.7	6.6	5.5	5.9	6.1	11.9
Operatives	2.3	2.5	2.9	2.3	2.1	2.1	2.4	9.5
Service occupations	2.3	1.3	1.1	2.3	3.0	2.0	2.0	3.1
Farm laborers and foremen	0.2	.5	.1	.2	.3	.5	.3	1.8
Laborers (except farm)	1.0	.3	.5	.6	.3	1.0	.6	4.7
Housewives	18.2	13.5	10.3	20.6	17.0	15.2	15.8	43.9
Students	18.4	21.6	24.8	12.8	20.2	21.6	19.9	
Retired or other	3.1	2.8	2.0	2.1	2.1	1.8	2.3	
No report								1.7

Family Income	I	II	III	IV	V	VI	Mean	Census
less than $1000	.8	1.1	1.3	.9	1.2	.2	.9	9.5
$1,000 - 1,999	2.0	.6	1.6	1.0	1.4	1.9	1.4	11.7
$2,000 - 2,999	2.4	1.6	1.9	1.5	1.4	2.8	1.9	7.9
$3,000 - 3,999	3.9	2.7	2.6	3.5	2.7	4.1	3.2	8.2
$4,000 - 4,999	5.9	5.4	6.9	4.7	4.9	5.5	5.6	9.8
$5,000 - 5,999	12.0	8.8	10.3	9.0	9.8	9.7	8.1	11.7
$6,000 - 6,999	12.5	10.1	9.6	10.7	11.2	9.9	10.6	10.1
$7,000 - 7,999	9.8	9.3	8.3	11.1	10.5	9.0	9.7	7.9
$8,000 - 8,999	8.7	8.6	9.3	9.6	9.3	7.8	8.9	6.1
$9,000 - 9,999	7.8	10.5	8.1	7.8	9.8	8.1	8.7	4.4
10,000 -14,999	23.6	24.3	24.3	24.0	22.8	24.7	23.9	9.3
15,000 -24,999	7.8	11.4	10.7	11.7	8.9	11.8	10.4	2.5
25,000 or over	2.9	5.6	5.0	4.4	6.2	4.3	4.7	0.9

	I	II	III	IV	V	VI	Census
Median Income Category	$8000-9000	$9000-10000	$8000-9000	$8000-9000	$8000-9000	$8000-9000	$5000-6000

Table 5:2 (continued)

Residence	I	II	III	IV	V	VI	Mean
Seattle	15.4	14.8	10.0	15.9	21.3	15.6	15.5
Spokane	1.8	1.6	2.0	1.7	1.6	2.0	1.8
Tacoma	2.7	1.7	2.7	2.3	3.3	3.2	2.6
Other Washington	21.6	12.2	13.1	18.5	17.6	18.7	16.9
California	15.6	21.5	22.6	20.8	18.3	14.5	18.9
Oregon	9.1	8.8	8.7	8.3	7.1	8.4	8.4

Sex	I	II	III	IV	V	VI	Mean
Male	56.9	63.4	66.3	58.5	60.1	62.5	62.6
Female	43.1	36.6	33.7	41.5	39.9	37.4	37.2

In order to make the samples more comparable, a subsample was drawn for each attitude interviewing area. The subsamples were equated for educational level (equal proportions having "some college" and "no college"), and for sex. Within each subsample were 766 cases. Table 5:3 shows the background characteristics of the subsamples. The general effect of subsampling was to reduce overall differences.

These subsamples provided the data for before-and-after comparisons of attitude scale items.

Sampling Methods for Information Interviews:

The information questions were asked at the beginning and end of Hall IV, using the same sampling method--random selection from different grid areas--that has been outlined above. The problem of sample bias was not, however, handled in the same way. Rather than comparing the two samples on background characteristics, they were compared on a series of control questions.

It will be recalled that the Acorn Test of General Science Information was included in a subsample of interviews. With a few exceptions, the items therein were not likely to be influenced by the exhibits in Hall IV, since the required information was not on display. We reasoned that before-and-after answers to the Acorn items could differ significantly only if the original knowledge of our two samples differed significantly. But if responses to the items did not differ, then the knowledge level of the two samples would be essentially equivalent, and no subsampling would be necessary.

An evaluation of these control questions gave us no reason to feel that the samples differed on initial knowledge, so no subsampling was done.

Table 5:3

Background Characteristics of

Attitude Respondents: Equated Subsamples

Per Cent of Respondents, by Interview Area

Age	I	II	III	IV	V	VI
14-19	12.6	14.1	17.0	10.0	16.3	14.9
20-24	11.3	14.8	16.1	8.9	14.4	18.5
25-29	11.8	12.8	10.9	6.6	11.6	11.6
30-34	8.8	6.9	8.1	9.5	8.1	9.4
35-39	11.3	10.7	10.3	17.0	12.0	10.7
40-44	11.2	12.3	10.7	17.6	9.5	12.0
45-49	[illegible].2	9.8	8.3	13.6	8.5	7.5
50-54	8.1	9.2	6.4	7.8	8.0	5.2
55 and over	15.6	9.3	12.0	9.1	11.5	10.1

Education	I	II	III	IV	V	VI	
Some grade school	.3	.1	.3	.6	.5	.1	
Completed grade school	3.9	3.3	1.6	2.3	3.3	2.7	
Some high school	13.0	11.9	14.4	10.2	13.7	12.9	36.8*
Completed high school	19.6	21.5	20.6	23.6	19.3	21.0	
Some college	29.6	28.6	29.9	28.8	29.6	30.0	
Completed college	13.7	13.4	12.3	14.5	12.8	14.9	63.2*
Some graduate school	11.5	11.2	10.8	9.5	8.7	10.3	
Holds advanced degree	8.4	9.9	10.2	10.3	12.0	8.0	

Sex	I	II	III	IV	V	VI
Male	61.9	61.9	61.9	61.9	61.9	61.9 *
Female	38.1	38.1	38.1	38.1	38.1	38.1 *

* Samples equated on this variable.

Table 5:3 (continued)

Occupation	I	II	III	IV	V	VI
Professional and technical	24.7	27.5	26.8	29.0	27.9	27.8
Farmers and farm managers	2.0	1.0	1.4	1.8	1.2	2.1
Managers, officials, proprieters	12.8	10.8	10.0	11.9	9.0	8.1
Clerical	7.7	8.5	8.9	7.0	7.3	8.0
Sales	3.1	2.7	3.3	2.2	4.0	3.4
Craftsmen and foremen	6.7	5.6	7.0	7.2	5.7	6.3
Operatives	2.2	2.7	2.5	2.6	1.8	2.2
Service Occupations	2.3	1.4	1.2	2.3	3.1	2.0
Farm laborers and foremen	.3	.4	.1	.1	.4	.4
Laborers (except farm)	.8	.4	.4	.5	.4	.8
Housewives	16.4	14.0	11.6	19.6	16.2	15.7
Students	17.7	27.2	25.5	13.7	20.5	21.5
Retired or other	3.3	2.6	2.2	2.0	2.3	1.8

Family Income	I	II	III	IV	V	VI
Less than $1,000	.8	1.1	1.2	.9	1.3	.3
$1,000 - 1,999	2.0	.7	1.5	1.2	1.6	2.0
$2,000 - 2,999	1.8	1.6	1.9	1.4	1.3	2.8
$3,000 - 3,999	3.4	2.8	2.7	3.4	2.6	4.6
$4,000 - 4,999	6.1	5.4	7.0	4.0	4.7	5.9
$5,000 - 5,999	11.4	8.5	10.5	9.0	10.0	9.2
$6,000 - 6,999	12.2	10.4	9.6	11.1	10.8	9.8
$7,000 - 7,999	9.9	9.0	8.1	11.1	10.3	9.5
$8,000 - 8,999	8.7	8.4	9.4	9.4	9.7	7.4
$9,000 - 9,999	8.2	10.0	8.1	7.4	10.0	8.6
10,000 - 14,999	24.2	24.8	24.3	24.8	22.8	25.6
15,000 - 24,999	8.3	11.7	10.5	12.1	8.8	10.7
25,000 - or over	2.9	5.7	5.3	4.1	6.2	3.8

	I	II	III	IV	V	VI
Median Income	$8000-9000	$8000-9000	$8000-9000	$8000-9000	$8000-9000	$8000-9000

Table 5:4 shows how many information subtests were collected both before and after Hall IV, by particular subtest and by interview method.

Table 5:4

Number of Information Interviews Collected:
By Subtest, Area, and Interview Method

	Area		Method	
Subtest	Before Hall IV	After Hall IV	By Machine	By Magnetic Board
Applied Physics	585	594	454	725
Macrophysics	442	438	333	547
Botany	440	440	316	564
Geology	440	440	316	564
Human Physiology	296	296	190	402
Biology	437	438	324	551
Behavior	585	582	444	723
Nuclear Physics	293	291	176	408
Acorn General Science Test	1040	1035	792	1283

The Samples That Weren't:

Initially, we had planned to collect interviews at two other sites as well: on the fairgrounds outside the pavilion, and at the exit of Hall V. In both cases an initial attempt was made; in both cases interviewing was discontinued.

Interviews on the fairgrounds would have shown whether the Science Exhibit attracted the usual run of fairgoers, or whether it had a differential appeal. In order to get a random sample of fairgoers, interviewers at first contacted people immediately as they entered the Fair. Not surprisingly, at least seven out of ten refused to stop: they had just paid their admission fee, they wanted to see the Fair, and they were in no mood to chat. Nor were interviews elsewhere more successful. At the Science Pavilion, people did not mind being interviewed, especially since they could sit down while talking, and often would have been waiting in line anyhow for something to start. These conditions did not prevail on the fairgrounds. The sampling bias from a 75% refusal rate being exorbitant, interviews on the fairground were reluctantly discontinued.

Hall V, on "the public implications of science," presented other problems. At various times throughout the fair it was closed for repairs or re-evaluation. It attracted relatively few people and those only for a three-minute period. The one possible interviewing area was exposed to wind and weather, and Seattle's climate is sometimes less than balmy. All of these factors militated against before-and-after interviews at this Hall; therefore, interviewing was discontinued.

Background Characteristics of the Samples: Some General Propositions

The samples collected at each interviewing area were not entirely representative of Pavilion attendance as a whole; the preceding pages have detailed their limitations. This being so, any general statements about the people who came to the Science Exhibit must be made with caution. On the other hand, the samples in each interviewing area were strikingly similar and at the same time different from the general populace; in this section are detailed some of the differences. For maximum clarity, the findings are presented as a series of propositions. It should be recognized that the precise-sounding figures given below are more tentative than one might wish, since we do not know the characteristics of the people who refused to be interviewed.

Proposition 5:1 The majority of people at the Pavilion came from three Western states: Washington, California, and Oregon. As table 5:2 shows, Washington residents made up 36.89 per cent of the total sample. Washingtonians came almost equally from Seattle, and from the rest of the state. California contributed 18.89 per cent, and Oregon 8.41 per cent.

Proposition 5:2. In general, people attending the Pavilion were more highly educated than average. Approximately 64 per cent of those interviewed had some college training, and about 10 per cent held advanced degrees. For comparisons sake, only 21 per cent of Washington residents have college training, according to the 1960 census.

Proposition 5:3. In general, people attending the Pavilion were middle class, with a higher income and a higher status than average. The median income for our sample is between eight and nine thousand dollars, approximately three thousand more than the average family income in Washington state. In our interviews, the professional people far exceeded national norms, as did managers, officials and proprieters. There were relatively few blue-collar workers. (See Table 5:2).

Proposition 5:4. The Pavilion drew more men than women, and drew relatively few housewives. Only 37.2 per cent of our sample were women, and only 15.8 per cent housewives.

In Brief:

1. Sampling at a fair presents a number of unique technical problems: refusal rate is high, the population varies by hour, day, and month, and the sampling base changes proportionally to the crowd count.

2. To lessen refusal ratio, two innovations in interview techniques were adopted: magnetic rating boards, and a branching-program teaching machine.

3. Since a truly representative sample could not be obtained, given the complexity of the population universe, much attention was paid to getting comparative samples from each interviewing area. By comparative sample is meant one in which the sampling biases were constant for each interviewing area. For attitude interviews it was necessary to draw samples from each area at comparable hours, days, and months. Attitude samples were further subsampled so as to give groups equivalent on education and sex.

4. A check on comparability was provided in the information interviews by the use of control items: questions on which no information increase would be expected. Since the percentage of right responses to these questions did not change by sampling area, the samples were assumed to be comparable.

5. Although the interviews are not completely representative, they suggest that the average Pavilion visitor differed significantly from the normal population. In general, education was greater, housewives were under-represented, the proportion of professional people was higher, and there were relatively few blue-collar workers.

CHAPTER VI

ATTITUDES AND THEIR CHANGE

The reader will recall that attitude questions were asked of fairgoers at six different spots in the Science Pavilion. The different samples gave a before-and-after picture of attitudes for each of the major exhibit halls. In this chapter, results from these interviews will be reported.

But before plunging into the statistical results, it might prove helpful to pause a moment and ask, "What can we expect to find?" To this question there are two sorts of answer, one based on the types of attitude change which can occur, the other based on the content of attitude change.

On the Types of Attitude Change

Consider briefly two types of possible attitude change. The first might be labelled a shift in average attitude. Thus fairgoers as a whole could come to regard scientists as more or less intelligent, more or less conservative, etc. This is usually what is meant when one speaks of attitude change; it is what the public opinion polls usually report.

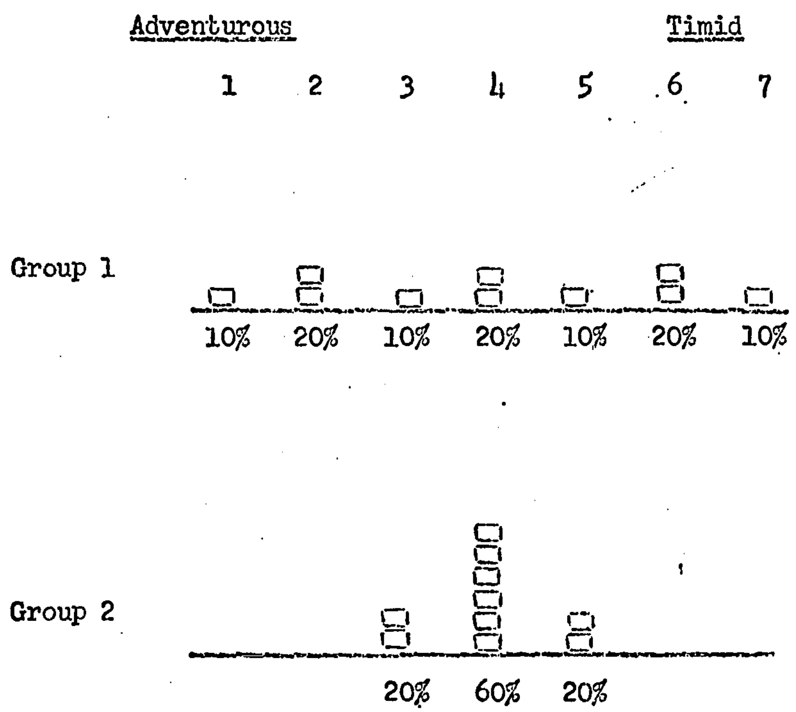
The second kind of change we may label as a change in the spread of attitude. Two different groups of people can have the same average attitudes about scientists, yet differ greatly in their attitude range.

People in one group could disagree strongly among themselves, while those in a second group could be in essential agreement. Figure 6:1 illustrates this kind of situation:

Figure 6:1

An Example of Attitude Spread

Question: Describe Scientists on the following rating scale.



Group 1 and group 2 have the same *average* attitude, but group 1 is marked by considerable disagreement, while group 2 shows general agreement.

In the findings reported below, both types of attitude change are examined. Average (mean) attitudes are cited for each of the six sampling areas, and differences between them evaluated statistically.

The spread of attitude is also reported; using a measure of dispersion, the standard deviation. Differences in dispersion are evaluated statiscally between each adjacent subsample.[1]

<u>On the Content of Attitude Change</u>

Can changes in attitude really be expected in the Science Pavilion? And if so, where, and in response to what? Although we avoided setting up specific hypotheses, we did have a few hunches, based in large part on the announced intent of the various exhibit halls. Table 6:1 lists certain attitude changes which we felt could be reasonably expected in each Pavilion Hall.

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1. The non-technical reader may find an explanatory note helpful at this point, since some understanding of statistical logic is required for the following pages.

Suppose we find (as we did) that after seeing the "House of Science" movie, people rated "Scientists" as being <u>more</u> "eccentric." Can we conclude that this is a real and solid shift in attitude? Or could it just be one of those fluctuations that occur by chance? To this question, certain statistical procedures provide a qualified answer.

We can never entirely rule out the possibility that a change occurs by chance; the best we can do is to figure the odds, and discover how often such a change might be expected by chance alone. In social and psychological research, there is a convention that we disregard findings which could occur more often than one time in twenty by chance--or at least be extra cautious in evaluating them. Of course if a finding could hardly ever occur by accident--say one time in a thousand--then we would be even surer of our ground. A variety of statistical techniques are used to figure the odds; in this paper the three most commonly employed are the t test, the F test, and the chi-square test. For conveniences sake, the odds are usually reported in a kind of shorthand: $p \leq .05$ means, for instance, that the difference between our two samples could occur only five per cent of the time by chance. This is also sometimes spoken of as a confidence level; in this example, $p \leq .05$ refers to the five per cent confidence level.

Table 6:1
Hypothesized Attitude Changes by Pavilion Hall

Hall	Announced intent	Possible attitude changes
I	The House of Science--a film introducing and explaining the general philosophical framework in which all scientists must work...The growth of science is reviewed...Scientists are shown at work in a range of settings...Science is an artistic or philosophical enterprise, carried on for its own sake; scientist views nature as a series of interlocking puzzles which he can solve.	Here, more than anywhere else in the pavilion, the public is exposed to general statements about science and scientists. If effective, we would expect here to find the most attitude change. The emphasis on science as a human enterprise might be expected to make the scientist seem less unusual, less eccentric, and science seem warmer, less forbiddingly impersonal and perfect. The emphasis on science as an intellectual persuit might well cause a shift away from the view of science as "fact finding" or "utilitarian".
II	Development of Science--exhibits which show the evolution of science from man's earliest curiosity about the phenomona of nature through the development of tools to aid him in his quest for knowledge. Modern work in genetics, theoretical physics, etc. is placed in its historical context. The viewers also are exposed to a group of visual illusions, emphasizing the limitations of the unaided senses.	The exhibits here are much less general in their stated message than was the film: they deal with complex subjects in a relatively thorough way. If attitude changes occur, it will be because a more general message was inferred--that science results from curiosity, that scientists are more concerned with understanding than with technological applications, that scientific theory is more than ideas, but involves experimentation to see if the ideas are correct. Scientific ideas might be seen as more changeable therefore. Perhaps too the potentials of science might be seen as greater, since much modern scientific work is explained.

Table 6:1 (Continued)

Hypothesized Attitude Changes By Pavilion Hall

Hall	Announced intent	Possible Attitude Changes
III	The Spacearium--A simulated journey through the universe. Past the moon, past the sun and planets, the filmed trip procedes into the milky way, and thence into intergalactic space. Intended to give a feeling of the immensity of the universe, and the relative smallness of ourselves and our earth.	Apart from a generalized feeling of awe, perhaps reflected in the evaluative rating scales, little attitude change could be expected on our measures--the exhibit not dealing specifically with the attitudes we probe. It may be, however, that science will be seen as having greater potentialities.
IV	Methods of Science--Demonstrations of how answers are being sought in several significant areas of scientific research. Each display sequence begins with a general question; the rest of the display deals with current work designed to answer the inquiry. A variety of display techniques are used, including several sections with "live" demonstrations, the demonstrators being usually college girls.	Here too the exhibits deal with specific work on specific problems; if a generalized change in attitude occurs, it will be because the public has abstracted a more generalized message from the concrete particulars of the displays. If so, we would expect changes to occur on questions dealing with the scope and meaning of science. There might be more people describing science as a method for finding out answers to questions. Perhaps the presence of female demonstrators would make the image of science less masculine.
V	Horizons of Science--A climax and conclusion which portrays and projects how the outcomes of science influence the life of man, now and in the future.	Sampling and technical problems precluded an examination of attitude change in this area.

As the table makes clear, the halls differed considerably in the complexity and the specificity of their message. In a sense, the displays called for more work from the audience than did the movies--the displays talked about specifics, without often stating the underlying message.

What actually happened to attitudes as the people went through the halls? In the pages which follow, we shall first describe the attitudes that people brought with them to the Pavilion, and then discuss the attitude changes which took place. Our findings are again presented as a series of propositions, with the evidence for each reviewed.

The Initial Attitudes

Proposition 6:1 For our sample, scientists enjoy extremely high prestige, but with some reservations expressed. On the adjective ratings, "scientists in general" were described as extremely intelligent, original, interesting, adventurous, and active. Forty-seven per cent of the sample drawn from Hall I (before entering the Science Pavilion) felt that "scientists should have a strong voice in the government," 27% were neutral, and 26% disagreed. On the other hand, a majority (61%) felt that "individual scientists should take more responsibility for the way scientific discoveries are used, 17% were neutral, and only 22% disagreed. In a way, these last two findings reinforce the picture of high prestige given by the adjective ratings: if scientists are indeed such fine people, it is natural that they should be asked to take more responsibility in government and out.

Slight reservations in this generally favorable picture are also apparent from two of the adjective ratings. Scientists are described as eccentric people, unusual people. Thus 46% of the initial sample rated scientists as being at least somewhat eccentric, 28% gave a neutral rating, and only 26% saw them as conventional people.

Complete tabulations of semantic differential ratings for the concept, "Scientist," are to be found in Appendix XIII; the mean ratings and standard deviations are given in Table 6:2.

Table 6:2

Semantic Differential Ratings for the Concept, "Scientist"

Interviewing Area I, Corrected Sample[1]

Item			Mean	Standard Deviation
Relaxed	1 2 3 4 5 6 7	Tense	4.46	1.65
Polished	1 2 3 4 5 6 7	Socially Clumsy	3.90	1.48
Leisurely	1 2 3 4 5 6 7	Hasty	3.55	1.69
Proud	1 2 3 4 5 6 7	Humble	4.21	1.92
Stupid	1 2 3 4 5 6 7	Intelligent	6.58	.80
Well Paid	1 2 3 4 5 6 7	Poorly Paid	4.06	1.75
Adventurous	1 2 3 4 5 6 7	Timid	2.42	1.57
Boring	1 2 3 4 5 6 7	Interesting	5.92	1.40
Active	1 2 3 4 5 6 7	Passive	2.68	1.68
Calm	1 2 3 4 5 6 7	Agitated	3.59	1.70
Unoriginal	1 2 3 4 5 6 7	Original	5.95	1.29
Eccentric	1 2 3 4 5 6 7	Conventional	3.73	1.63
Unusual	1 2 3 4 5 6 7	Usual	3.51	1.72

1. These figures are corrected for sampling bias, as discussed in Chapter V.

<u>Proposition 6:2 For our sample, science is highly regarded, but is seen as having definite limitations.</u> In the adjective ratings, "Science as a whole" was described as extremely valuable, good, motivated, constructive, and leading. On the "good-bad" dichotomy, for instance, 80% of the sample from Hall I rated science as "1" or "2" on the 7-point scale.

On the other hand, some things are more important than science. Science is described as "incomplete" by 54% of the initial sample, and 52% feel that "God's word is more important than anything the scientists turn up in their studies." Science is seen as having real limitations: our sample tends to feel, for instance, that science cannot ever understand enough about human beings to eliminate poverty and crime, that science will never be able to create life, and that scientists will never be able to predict and control the behavior of individual people. It should be noted, however, that talking about <u>average</u> public attitudes is in some cases rather misleading. For instance, there is marked disagreement about whether science will ever be able to create life, or whether God's word is more important than anything the scientists might discover: on these issues opinions seem to be strongly held and quite divergent.

Complete tabulations of adjective ratings for the concept, "Science," are given in Appendix XIV; the mean ratings and standard deviations are shown in Table 6:3.

Table 6:3

Semantic Differential Ratings for the Concept, "Science"

Interviewing Area I, Corrected Sample[1]

	Item		Mean	Standard Deviation
Perfect	1 2 3 4 5 6 7	Imperfect	4.05	1.51
Certain	1 2 3 4 5 6 7	Uncertain	3.91	1.75
Following	1 2 3 4 5 6 7	Leading	5.83	1.29
Aimless	1 2 3 4 5 6 7	Motivated	6.25	1.07
Complete	1 2 3 4 5 6 7	Incomplete	4.70	1.91
Valuable	1 2 3 4 5 6 7	Worthless	1.30	.89
Unintelligible	1 2 3 4 5 6 7	Intelligible	6.23	1.07
Constructive	1 2 3 4 5 6 7	Destructive	1.87	1.19
Youthful	1 2 3 4 5 6 7	Mature	4.49	1.94
Feminine	1 2 3 4 5 6 7	Masculine	4.86	1.20
Cold	1 2 3 4 5 6 7	Warm	4.33	1.52
Good	1 2 3 4 5 6 7	Bad	1.81	1.17
Calm	1 2 3 4 5 6 7	Excitable	4.60	1.90

1. These figures are corrected for sampling bias, as discussed in Chapter V.

Proposition 6:3 In our sample, science is seen mainly as a method of finding out about things by forming hypotheses and checking the hypotheses by experiments, or else as an attempt to analyse problems by breaking them down into parts. But understanding is vague. Table 6:4 shows the percentage of endorsement for each definition of science. It will be noted that certain definitions, which on an *a priori* basis would seem widespread, are not often endorsed. Thus the technological aspect of science--"an attempt to make the world a better place by discovering new inventions and facts"--is seldom taken as a major definition. A certain vagueness of understanding is implicit however in the frequent endorsement of one item, "Any search for truth should be called a science," which was ranked first by 20% of the initial sample. Some vagueness may be inferred also from the results when people were asked which of four occupations were scientific. The majority felt that all--including electronics engineers, physicians, psychologists, and physicists--were scientists.

Patterns of Attitude Change

Proposition 6:4 Portions of the Pavilion produced significant changes in attitude, but the changes were of slight magnitude. The preceding discussion reports findings only for those people who had not yet gone through the Science Exhibit. But the general conclusions would have been the same if we had reported data for people who had gone through all of the buildings. Attitude change was slight; in no case did the mean adjective ratings vary more than half a point on the seven-point scales. But although changes were slight, many were significant in a statistical sense. An example--in the before-and-after

Table 6:4

Percentage Endorsement of Science Definitions

First, Second, and Third Choice Reported

Interviewing Area I, Corrected Sample[1]

Item	1st Choice	2nd Choice	3rd Choice
Science is simply a matter of logical thinking. The scientist tries to figure out problems in a logical way.	6.4%	11.0%	15.6%
Science is simply a method of finding out about things. The scientist tries to figure out how something happens; then he tests his ideas with further observations to see if they are right.	27.6%	28.5%	20.1%
Science is an organized collection of facts. The scientist's job is to collect facts on various problems.	6.3%	10.6%	16.2%
Scientists are people who break things down into parts and elements, in order to see how they fit together. Science is a keen analysis, an attempt to figure out important things by breaking problems down into parts.	29.1%	27.8%	16.3%
Science is simply an attempt to make the world a better place by discovering new inventions and facts. The scientist is a person who attempts to produce better things for better living	10.4%	11.1%	15.8%
The scientist is anyone who is searching for truth. Any search for truth should be called a science.	20.5%	10.8%	15.8%

1. These figures are corrected for sampling bias, as discussed in Chapter V.

comparisons of the "House of Science" film, 19 attitude measures out of 45 showed changes significant at the .05 level or below.

Proposition 6:5 The majority of significant attitude changes occurred in response to the first hall, the "House of Science" film. The film's general effect was to make scientists seem more academic, and more eccentric. Science came to be seen as warmer and more feminine, but the public's concept of science became more vague. As noted above, 19 out of 45 attitude measures showed a significant change for the sample exposed to the "House of Science" film. This may be compared with the effects of Hall II (Development of Science), where seven attitudes showed a significant change; with the effects of the Spacearium, where seven attitude measures changed significantly; or with the effects of Hall IV (The Methods of Science), where two significant attitude changes were found. The "House of Science" film was thus more effective in changing attitudes--at least for those attitudes we measured.

Table 6;5 lists the particular attitudes which showed a significant shift after the Eames' film.

Apparently the effects of the film were varied. The change in the attitude statements suggests that science came to be viewed as having greater potential in areas which were previously considered beyond its province. The adjective rating of scientists showed shifts mainly in two dimensions: the Quiet-Scholar stereotype (poorly paid, humble), and Eccentricity (eccentric, unusual). Changes in attitude toward science were particular to specific adjectives; entire factors did not change. Science came to be seen as more feminine, excitable,

Table 6:5

Attitude Measures Showing Significant Changes Between Interviewing Areas 1 and 2, Corrected Sample.[1]

Measure: Attitude Statements	Mean rating Area I	Mean rating, Area II	Effect
Likelihood of science eliminating crime and poverty	2.89	3.10 *	Likelihood increased
Likelihood of science being able to change heredity and create new species.	4.23	4.73 **	Likelihood increased
Likelihood of science creating life	3.47	3.78	Likelihood increased
God's word more important than science	4.53	4.08 **	Disagreement increased
Scientist ratings			
Proud-Humble	4.21 **	4.50	more humble
Socially Polished - Clumsy	3.90 *	4.09	more clumsy
Well-paid -- Poorly paid	4.06 **	4.34	more poorly paid
Eccentric - Conventional	3.73 **	3.49	more eccentric
Unusual - Usual	3.51 *	3.32	more unusual
Science Ratings			
Feminine - Masculine	4.86 **	4.67	less masculine
Cold - Warm	4.33 **	4.58	more warm
Calm - Excitable	4.60 **	4.87	more excitable

1. These figures are corrected for sampling bias, as discussed in Chapter V.

* Change significant $p \leq .05$

** Change significant $p \leq .01$

Table 6:5 (Continued)

Who is a Scientist?	percentage checking, Area I		Percentage checking, Area II
Engineer	72%	**	78%
Physician	52%	**	65%
Physicist	86%	**	92%
Psychologist	52%	**	67%

Definitions	Area I % endorsing 1,2,3		Area II % endorsing 1,2,3	Effect
Science is simply a matter of logical thinking. The scientist tries to figure out problems in a logical way.	33%	*	38%	more often endorsed
Science is simply an attempt to make the world a better place by discovering new inventions and facts...	38%	**	29%	less often endorsed
The scientist is anyone who is searching for truth...	47%	**	56%	more often endorsed.

* Change significant $p \leq .05$
** Change significant $p \leq .01$

and warm. The definitions of science changed too: it was less often viewed as a utilitarian matter, and instead was perceived more as any search for truth, or as an attempt to apply logic to problems.

Note that a few of these results were predicted in Table 6:1--but not all. There we had assumed that "the emphasis on science as a human enterprise might be expected to make the scientist seem less unusual, less eccentric..." Quite the opposite took place. As expected, however, science came to be viewed as warmer; the decreasing emphasis on the practical utility of science was also predictable. Unexpected was the finding that science was increasingly viewed as "any search for truth," or "simply a matter of logical thinking:" this implies that the concept of science as a thing in itself, a particular way of looking at the world and finding out about it, became _less_ clear.

Proposition 6:6 Although some attitude changes took place after exposure to Hall II (Development of Science), it is likely that these were not reactions to the exhibits there, but instead represented recovery from changes induced by the "House of Science" film. Table 6:6 lists the seven measures which show a significant difference in response when samples drawn from the beginning and the end of Hall II are compared. With one exception, these are all measures which showed a significant shift after exposure to the "House of Science" film. With no exceptions, the attitude changes represent a return towards attitudes held before exposure to the film. In general, it appears that attitudes do not swing back all the way; rather they stop at some point between the original attitudes and the attitudes found immediately after exposure to Hall I. All of this leads us to suspect that we are not

Table 6:6

Attitude Measures Showing Significant Change Between Interviewing Areas II and III, Corrected Sample[1]

Measure	Mean Rating Area II	Mean Rating Area III	Effect
Likelihood of a lunar landing by 1980	5.97 *	5.78	less likely
Rating of Scientist: Eccentric-Conventional	3.49**	3.67	less eccentric
Rating of Science: Cold-Warm	4.58**	4.37	less warm
Rating of Science: Calm-Excitable	4.87 *	4.68	less excitable

Occupation checked as Scientific:	% Checking Area II	% Checking Area III
Engineer	78%*	73%
Physician	65%**	59%
Psychologist	67%*	61%

* Change significant p≤ .05
** Change significant p≤ .01

here dealing with changes induced by Hall II alone, but are instead seeing a kind of "attitude recovery" phenomena. It is entirely possible, however, that Hall II might have had a differential effect on this recovery process, causing some attitudes to swing back, while reinforcing change in others.

One qualification needs to be made. The crowd flow into Hall II was such that people could enter by a side door, without having been exposed to the film in Hall I. We had anticipated that this would be rare. It was not as unusual as we had thought; in a subsample of 70 people who had visited Hall II, 13 had not viewed the "House of Science" exhibit (Cf. Chapter X). So our sample of people drawn from the exit to Hall II undoubtedly included many who had not viewed the initial film. Their attitudes then could be expected to be similar to those of people before entering the Pavilion. As a result, the attitudes expressed after Hall II should, on the average, be more like those of the initial sample. And this could account for the "attitude recovery" found.

However, not all of the changes can be attributed to the sampling. Some of the attitudes affected by the film showed a significant swing back towards their initial state, but more did not. We can only conclude that sampling error may have contributed something to the above findings, but does not totally account for the results.

Parenthetically, it should be noted that none of the attitude changes which we expected to appear (Cf. Table 6:1), actually appeared.

<u>Proposition 6:7 Although attitude changes appeared after exposure to the Spacearium, no obvious patterns emerged.</u> Table 6:7 shows those attitude measures in which a significant difference was found between before and after samples at the Spacearium. Oddly enough, the one measure in which change could be logically expected--the likelihood of a lunar landing by 1980--showed no mean attitude shift. There was, however, a significant shift in attitude dispersion on this measure, and greater <u>consensus</u> that a moon landing was possible. As for the other changes which occurred, no pattern seems readily perceivable.

<u>Proposition 6:8 The displays on Methods of Science produced minimal attitude change. There is no evidence that they changed or clarified the public's understanding of the scientific method.</u> Attitude change from Hall IV seemed confined to two measures: the likelihood that scientists could create new species of animals by changing heredity (which increased), and the rating of scientists as original or unoriginal (they were perceived as less original). On the rating of originality there was significantly less consensus after viewing Hall IV than before. The definitions of science showed no changes in the before-and-after comparisons. This latter finding suggests that the public did not increase in understanding of the scientific method by viewing specific examples of its application.

Table 6:7

Attitude Measures Showing Significant Change Between Interviewing Areas III and IV, Corrected Sample[1]

Measure	Mean Rating Area III	Mean Rating Area IV	Effect
Likelihood of new species created by changing heredity	4.77 *	4.54	less likely
God's word more important than science	4.06 **	4.47	more important
Likelihood of science creating life	3.84 *	3.54	less likely
Rating of scientist: Polished-Clumsy	4.15 *	3.99	more polished
Rating of science: Calm-Excitable	4.68 *	4.86	more excitable

Definitions:	Area III % endorsing 1,2,3	Area IV % endorsing 1,2,3.
Science is a matter of logical thinking ...	40% *	33%
Science breaks problems into parts...a keen analysis	69% *	75%

1. These figures are corrected for sampling bias, as discussed in Chapter V.

* Change significant $p \leq .05$
** Change significant $p \leq .01$

In Brief:

1. Two types of attitudes change were investigated, and the results reported in the present chapter. Studied were changes in average attitude, and changes in attitude dispersion.

2. *A priori* hypotheses were advanced, specifying the content of attitude change to be expected in each of the halls. The greatest attitude shift was expected in the first hall, where a film dealt directly with the issues here investigated. Attitude change in the other halls, if found, would probably be a result of the public's ability to generalize from the specific contents of specific displays.

3. The initial attitudes--those brought by the public to the Science Pavilion--could be summarized by three propositions:

   a. In our sample, scientists enjoyed extremely high prestige, but with some reservations expressed.

   b. In our sample, science is highly regarded, but is seen as having definite limitations.

   c. In our sample, science is defined mainly as a method for finding out things by forming hypotheses and checking the hypotheses with experiment, or else as an attempt to analyze problems by breaking them down into parts. But for a sizeable percentage, there are indications that understanding of science was vague.

4. Patterns of attitude change were analyzed separately for each Pavilion hall. Results were as follows:

   a. Portions of the Pavilion produced significant changes in attitude, but the changes were of slight magnitude.

b. The majority of significant attitude changes occurred in response to the "House of Science" film in Hall I. The film's general effect was to make scientists seem more academic and more eccentric. Science came to be seen as warmer and more feminine, but the public's conception of science became more vague.

c. Although some attitude change took place after exposure to Hall II (Development of Science), it is likely that the change came not as a reaction to the exhibits there, but instead represented recovery from changes induced by the "House of Science" film.

d. Attitude shifts appeared after exposure to the "Spacearium" show in Hall III, but no obvious patterns of change were readily perceivable.

e. The displays in Hall IV on "Methods of Science" produced minimal attitude change. There is no evidence that they changed or clarified the public's over-all understanding of the scientific method.

CHAPTER VII

THE RETENTION OF INFORMATION

Louis Gray

What did people learn at the Science Pavilion? This question was investigated in detail for Hall IV, presenting the "Methods of Science." Eight specific subtests, each containing from 6 to 16 questions, were given to people entering, and to those leaving, Hall IV. This chapter presents our preliminary findings.

An analysis of the information retention might be conducted in several ways. Initially it might be concerned with changes occurring to each of the eight specific tests; this type of analysis should indicate what subject matter areas best communicated their information. A second type of analysis might concern specific questions: individual items would be examined to see which contribute most change. This second type of analysis should indicate those <u>specific</u> parts of displays and display areas which best communicate to the public.

Types of Information Retention

The types of information retention which may have occurred in the Science Pavilion fall into two basic categories: 1) retention of a specific bit of information, and 2) retention of general principles or terms abstracted from specific exhibits.

The second type of retention noted above may itself be subdivided. The abstraction of principles and terms may occur at a high level (as in abstracting basic principles of scientific method from specific examples of its application) or at a low level, involving only a simple recollection of words. Thus a visitor to Hall IV might come away knowing terms such as "DNA" or "Van Allen Belts" yet having no idea of their referents.

The relation of these types of retention to evaluation of changes occurring in Hall IV is apparent. An increase in the probability of an item being correctly answered after a person has seen Hall IV may be due to having "learned" that specific item, or else to having abstracted from the exhibit. If abstraction is the cause, then the change in probability may be due to either a high or low level abstraction. Simple knowledge that "DNA" is a term which has a referent in modern science may increase probability of endorsement in an item for which "DNA" is an alternative and other alternatives are not recognized.

For the most part it will be impossible to definitely isolate the type of information retention occurring on any specific item. In many cases it is reasonable to assume that both types are occurring. Analysis of the items should give some indication of the dominant type of retention occurring in each of the subject matter areas.

Over-all Changes Occurring in Hall IV

This preliminary stage of the analysis was performed by means of tests for significance of difference in proportions of correct responses between the beginning and end of Hall IV. The units of analysis are not persons or test scores but the questions being asked in the tests. Discovery of a significant difference (at the 5% level) indicates that, in general, information measured by the test had been retained.

This type of analysis neglects the fact that the items on a test were not of equal difficulty. This problem resolves itself, however, since the mean difficulty level for each test is approximately fifty per cent, and the items within each test are similarly distributed with respect to difficulty.

Proposition 7:1 Though the experience of having seen Hall IV produced significant changes, in five out of the eight specific tests the amounts of change were consistantly small.

Table 7:1 shows the proportions of correct responses before Hall IV, the proportions of correct responses after Hall IV, and the difference between them. The reader will notice that changes range from a high of 5.8 per cent for the test on Behavior to a low of -.7 per cent for the test on Botany. (The two negative changes observed are too small to be significant.)

The small size of the differences shows that over-all a low level of retention occurred relative to the enormity of information contained in Hall IV. Yet the size of the samples allows us to conclude that the differences discovered are real and meaningful. Consideration of the circumstance surrounding a visitor to the Science Pavilion, in the middle of a world's fair, suggests that only small amounts of information retention could be expected. The atmosphere of a fair could hardly be supposed to be conducive to the learning of detailed scientific information, such learning requiring concentration and some expenditure of time.

Table 7:1

Over-all Changes in Specific Subject Matter Areas

Subject Matter Area	% Correct Before	% Correct After	Difference	Z (Test Statistic)
Applied Physics	48.9	52.4	3.5	4.67**
Macro-Physics	50.1	52.9	2.8	3.32**
Nuclear Physics	43.5	42.9	-.6	-.41
Behavior	42.5	48.3	5.8	6.87**
Botany	61.3	60.6	-.7	-.52
Geology	39.0	43.1	4.1	2.33**
Human Physiology	48.7	49.5	.8	.80
Biology	49.9	52.3	2.4	2.83 **

**Z at the 5% level of significance =1.65
Z at the 1% level of significance =2.33

Examination of the above table indicates that the eight tests divided rather neatly into two groups. The five tests which show significant differences (Applied Physics, Macro-Physics, Geology, Biology, and Behavior) show much greater change than those which are not significant. (Each of these tests shows a significant difference not only at the 5 per cent level but at the 1 per cent level as well.) None of the other tests even remotely approaches the level of significant difference.

This observation tends to indicate that there may be particular characteristics of the exhibits in these subject matter areas which the three areas not showing significant differences do not possess.

Proposition 7:2 Significant retention occurred in those subject matter areas which contained "live" exhibits.

The two largest changes occurred in the subject matter areas designated "Behavior" and "Applied Physics." Exhibits in the Behavioral section consisted mostly of work with animals: monkeys, pigeons, mice, salmon, etc. The Applied Physics exhibits were dominated by the actual satellite tracking station whose operation was explained to the audience by a live narrator of whom they could ask questions. The Biological section included a modern laboratory where young women conducted experiments and described them to the audience.

The exhibit areas included in Macro-Physics and Geology did not use "live" exhibits in the sense of animals or human guides, but they did contain actual examples or working models of equipment used for research in these areas. To be sure, models and examples were present in the subject areas where significant differences were not found, but the level of abstraction necessary to comprehend these seems to have been of a higher level. Thus the audience could see and comprehend a telescope, or a working model of the drilling barge Cuss I, but could not similarly comprehend a Cloud Chamber or a sympathetic ganglion.

Additionally the major portions of exhibit areas in Macro-Physics and Geology are in close proximity to the satellite tracking station. The changes in these areas may in part be due to this factor.

It seems reasonable to conclude that two kinds of exhibit areas are most likely to communicate information--those using "live" material, or those using working models on a low level of abstraction. Can we therefore conclude that retention occurred specifically within the "live" parts of these exhibits? Not at all, because the live aspects of exhibits might have drawn people to the exhibit, without themselves communicating much. Besides, it is impossible to infer the type of retention occurring in any particular case from this over-all analysis. In order to answer these questions an analysis of individual items is required.

The Retention of Specific Items

The analysis of individual items was accomplished by means of the Chi-square statistic. The frequencies of response to each alternative of an item before and after Hall IV were compared by means of this statistic. The results of the analysis allowed decisions as to whether the frequencies of response differed between the two interviewing areas by a significant amount and the type of change which occurred. As with the preceding analysis the 5 per cent level of significance was used.

Of the 104 items included in the eight subject matter areas, 25 were found to be significantly different after exposure to Hall IV. The total results of this analysis may be found in Appendices XV and XVI. Table 7:2 shows the breakdown into specific subject matter areas.

The number of items significantly different for any section seems fairly directly related to the amount of change for the whole test, reported earlier in Table 7:1. It will be noticed that in three cases the direction of change is negative, i.e., the item was answered correctly less often after exposure to Hall IV than before. Such a phenomena may be due to lack of clarity in the exhibit communicating the item, confusing effects of surround exhibits, or failure of the item to operate correctly when a subject has viewed Hall IV. In most cases it is difficult if not impossible to isolate the exact cause.

Proposition 7:3 The majority of the items in which significant changes occurred are associated with one of the three landmark exhibits in Hall IV.

The landmark exhibits, described in more detail in Chapter IX, all involve people or animals: The Satellite Tracking Station, the Biological laboratory, and the animal exhibits in the Behavioral section. These exhibit areas account for fully 16 of the 25 significant items. All changes are positive, and some are very large. Item 4 in the Behavior test, for example, shows an increase of fifteen per cent in correct responses.

The remaining question is, how closely are these items which show significant differences associated with the landmark exhibits?

Table 7:2

Breakdown of Significantly Different Items by Subject Matter Area

Subject Matter Area	Item Number (Significant Items Only)	Direction of Change
Applied Physics	4	Positive
	13	Positive
	15	Positive
	16	Positive
Macro-Physics	1	Positive
	3	Positive
	12	Positive
Nuclear Physics	6	Positive
	7	Negative
	11	Negative
Behavior	3	Positive
	4	Positive
	5	Positive
	6	Positive
	8	Positive
	9	Positive
	11	Positive
Botany	6	Negative
Geology	5	Positive
Human Physiology	13	Positive
Biology	4	Positive
	7	Positive
	8	Positive
	9	Positive
	10	Positive

Of the four items showing significant differences in the area of Applied Physics, two are directly related to the satellite tracking station, both referring to statements made verbally by the narrator. The other two items are contained in the exhibit on fuel cells, the most distant of the exhibits in the area on Applied Physics from the tracking station.

Unfortunately none of the items in the test on Biology dealt specifically with the laboratory. Of the five significant items in this area one referred to the cell model, two referred to the fireflies, and two referred to the DNA exhibits and the Watson-Crick hypotheses. Though it is, of course, impossible to assess the effects of the laboratory itself, it is of interest to note that the exhibits containing the significant items were all very close to the laboratory.

Of the seven significant items in the Behavioral section, four concerned the monkeys, two concerned the mice, and one concerned imprinting in chickens. All refer to live exhibits and more than half refer to the monkeys, considered to be the most popular exhibit in Hall IV.

Thus nine significant differences in items seem explainable in terms of the landmark exhibits. The items in Biology seem partially though incompletely explained and two items on the fuel cell remain unexplained. Explanation of these and other items requires consideration of crowd flow in Hall IV.

<u>Proposition 7:4 Items which are located along the paths of main crowd flow are more likely to show significant changes than items located elsewhere.</u>

No detailed discussion of crowd flow patterns will be attempted here: for a detailed analysis see Chapter IX. Only the general patterns will be considered. The main crowd flow pattern generally seems to follow lines of least resistance between the three landmark exhibits. Thus the average visitor to the Hall saw first the satellite tracking station, moved to the Biological laboratory, and then proceeded to the animal exhibits in the section on Behavior. (See Figure 9:3 Chap.IX) The majority of items showing significant changes definitely lie along this route.

Of the twenty-three items showing positive significant differences, all but five fall directly along the main traffic flow in Hall IV.(Figure 9:3) Of the five remaining items, one lies in the Nuclear Physics area, one lies in the Human Physiology area, and the remaining three fall in the Biological area. The discussion of the subsidiary crowd flow patterns in Chapter IX suggests that the changes occurring in the Biology and Human Physiology areas are associated with crowd overflow from the biological laboratory and the animal behavior exhibits.

The single item found positively significant in the Nuclear Physics exhibits seems partly explainable in terms of subsidiary crowd flow. For this item simple word recognition (resulting from passing through the exhibit area) could cause an increase in the percentage of correct response.

Of the three items found significant in a negative direction, two concern the Nuclear Physics exhibits and one concerns the exhibit on plant growth. Both of the items referring to Nuclear Physics lie outside of the main crowd flow and both represent a relatively high level of information, a level probably above anyone not specifically interested in learning the information contained.

The exhibit on plant growth, as can be seen in the chapter on crowd flow, received little attention. Examination of the item (see Appendix X) indicates that the wording alone may have caused the negative change.

It thus appears evident that several general factors influenced the retention of items: specifically, whether the items formed part of a landmark exhibit, whose location affected crowd flow, and whether it fell on the trails of certain fine patterns of the crowd flow. Can we determine more exactly what characteristics of information presentation contribute most to communication? Some indications of characteristics are indicated by the effects of the "live" exhibits discussed earlier, but final judgement must be based on more detailed examination of the presentation of specific items.

Specific Item Characteristics

During the intial stages of this project, the test items were analyzed to see how their information had been presented. Here we shall consider some of the variables in trying to determine what specific characteristics make for successful communication of information. (It is expected that a more complete analysis will be forthcoming as part of a doctoral dissertation by A. Dorius.)

Among the variables considered were: 1) whether or not movement was associated with item presentation, 2) whether or not the audience participated in the display (as in pushing a button to start display, etc.), 3) whether or not sound was associated with the display, 4) whether or not animals or narrators were present in the display, 5) and whether the exhibit was highly abstract, or relatively concrete.

Judgments on the displays were made by a team of judges. The reliability of observations seemed, on preliminary analysis, quite high, though exact reliability figures are not yet available.

<u>Proposition 7:5 An analysis of item characteristics tends to indicate that movement and sound are related to the tendency of an item to show significant differences.</u>

Table 7:3

Number of Significant Items Possessing
Certain Presentation Characteristics

Presentation Variables	Items Possessing Variable (number) Max=22
Movement	16
Participation by subject	2
Sound	11
"Live"	9
Abstraction	11

Of the twenty-two items showing positive significant results, sixteen either contained or were associated with movement. This movement varied from the movement of animals and live guides, to the movement of particles in a cloud chamber. To be sure, these types of movement may have different effects, but analysis of these differences has not been investigated at the present time.

Half of the significant items contained or were associated with sound, and half represented some degree of abstraction of the phenomena being discussed. Nine of the items were explicitly "live" in nature, having animals or guides associated with them. Only two of the items required the participation of the subject.

Although further analysis needs to be done on these item characteristics, and comparisons made between those itemswhich show significant changes and those which do not, it is possible to draw some preliminary conclusions. The characteristics which seem to be most important are movement, and sound. Judging from the changes in probabilities on the items, the presence of animals or guides is effective in bringing about larger differences in information retention. Participation of a subject in an exhibit seems to have little effect on information retention.

Table 7:4 shows the twenty-two positively significant items divided into upper and lower halves in terms of amounts of proportional change in correct response. As can be seen, the items with the greater before and after difference tend to be more strongly associated with movement, sound, and the presence of animals or guides. Items with lower differences tend to be more strongly associated with participation of a subject and are somewhat more abstract. The data in the table are by no means conclusive; more certain findings await further analysis.

Table 7:5 shows the relative association of significant and non-significant items with several presentation variables. The same tendencies noted in Tables 7:3 and 7:4 can be noted here. The significant items appear to possess more often characteristics of movement, sound, and the use of animals or humans. The non-significant items tend to possess slightly more participation by the audience and tend toward abstract presentation.

Table 7:4

The Relationship Between the Amount of Change Occurring on Significant Items and the Presence of Certain Presentation Variables

Presentation Variables	Items Possessing Variable (number: max=22)	
	Large Change	Small Change
Movement	9	7
Participation by subject	0	2
Sound	6	5
"Live"	5	4
Abstraction	5	6

Table 7:5

Percentage Distribution of Items Found Significant and Items Not Found Significant by Presentation Variables

Presentation Variable	Per Cent of Items Possessing Variable	
	Non-significant	Significant
Movement	54	73
Participation by Subject	12	9
Sound	42	50
"Live"	5	41
Abstraction	59	50

Types of Retention Occurring in Hall IV

It is difficult to be very specific about the types of retention occurring in Hall IV, but examination of the specific items suggests certain regularities.

Proposition 7:6 Each of the three types of retention discussed earlier in this chapter appears to occur in Hall IV, but high level abstraction retention seems to occur primarily in the Behavior exhibits.

Fourteen of the twenty-two positively significant items seem, in the main, to represent abstraction in the sense of simple word recognition. Of these, four are concerned with the Biology exhibits, two with the Applied Physics exhibits, two from the Macro-Physics exhibits, one from the Geology exhibit, one from the Nuclear Physics exhibits, and four from the Behavior exhibits.

Three items appear to represent specific information retention. One item from Biology, one from Human Physiology, and one from Macro-Physics.

Five items seem to show a degree of high level abstraction. Three of these are concerned with the exhibits on Behavior, and two with the exhibits on Applied Physics.

The reader must realize that the categories of retention, as described here, are hardly mutually exclusive. It is difficult to isolate clear-cut criteria by which such categories can be operationally defined. From a general standpoint, it appears that high level abstraction occurs primarily in the areas of Applied Physics and Behavior. Word retention seems most prevalent in the areas of Biology and probably in Nuclear Physics. The level of abstraction present in the exhibits contained in these subject matter areas may have assured this result.

Preferences for Exhibits in Hall IV

In addition to answering specific information questions, people interviewed at the end of Hall IV were asked to choose, from a set of color photos, pictures of the exhibits which they liked best. Table 7:6 shows the responses to this question by subject matter area.

Table 7:6

Percentage Distribution of Choices of Exhibit Areas

Exhibit Area	Percentage
Applied Physics	14.89
Macro-Physics	8.13
Botany	3.38
Biology	13.57
Human Physiology	12.98
Behavior	35.75
Nuclear Physics	6.86
Geology	4.46

Proposition 7:7 Exhibits picked as those enjoyed most were those in which the greatest retention occurred.

The two most popular exhibit areas were those concerning Behavior and Applied Physics, these being also the two areas in which the largest retention occurred. It should also be noted that the Behavior area is the only one which is chosen at a rate much greater than chance level. (Chance level being slightly over 12 per cent here.)

The percentage distribution in the above table also substantiates the landmark nature of the tracking station, the laboratory, and the Behavior exhibits.

The Relation Between Information Retention and Probability of Viewing an Exhibit

From the findings sketched above, it would appear that the popularity of an exhibit (in other words, the probability that it will be viewed), is the major factor contributing to information retention. If this supposition is correct, then there should be a high positive correlation between the probability of an exhibit being viewed and the average change in correct responses for items contained in that exhibit.

From the time-lapse analysis, reported in Chapter IX, it proved possible to estimate probabilities of visitors occupying certain areas in Hall IV. Table 7:7 indicates the probabilities associated with certain areas. The alphabetic designations correspond to those on Figure 9:3.

It was not possible, at this preliminary stage of analysis to estimate probabilities for all exhibit areas.

Thirteen of these exhibit areas could be directly associated with items in the information tests. The average change in per cent correct for the items associated with any of the areas was computed. Figure 7:1 shows the results of this analysis.

The correlation between the variables was .72, significant at the one per cent level. Though the relationship is strong, it can be seen that only about half of the variation in percentage of correct response can be explained by the probability of viewing an exhibit.

Some of the exhibit areas deviate noticeably from the least-squares regression line; these are of particular interest. The point

Figure 7:1

Relationship Between Mean Percent Increase
And Probability of Viewing

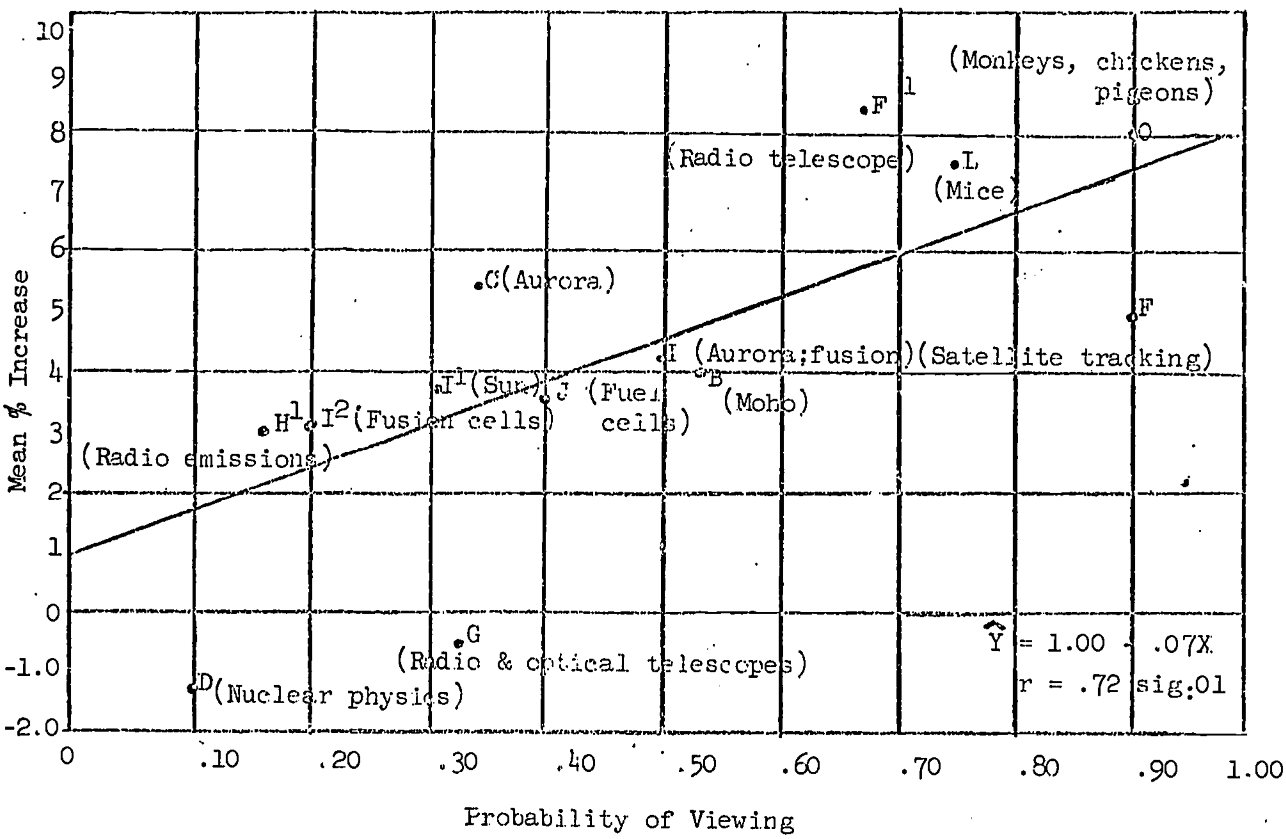


Figure 7:2

Relationship Between Mean Percent Increase Corrected
For Item Difficulty and Probability of Viewing

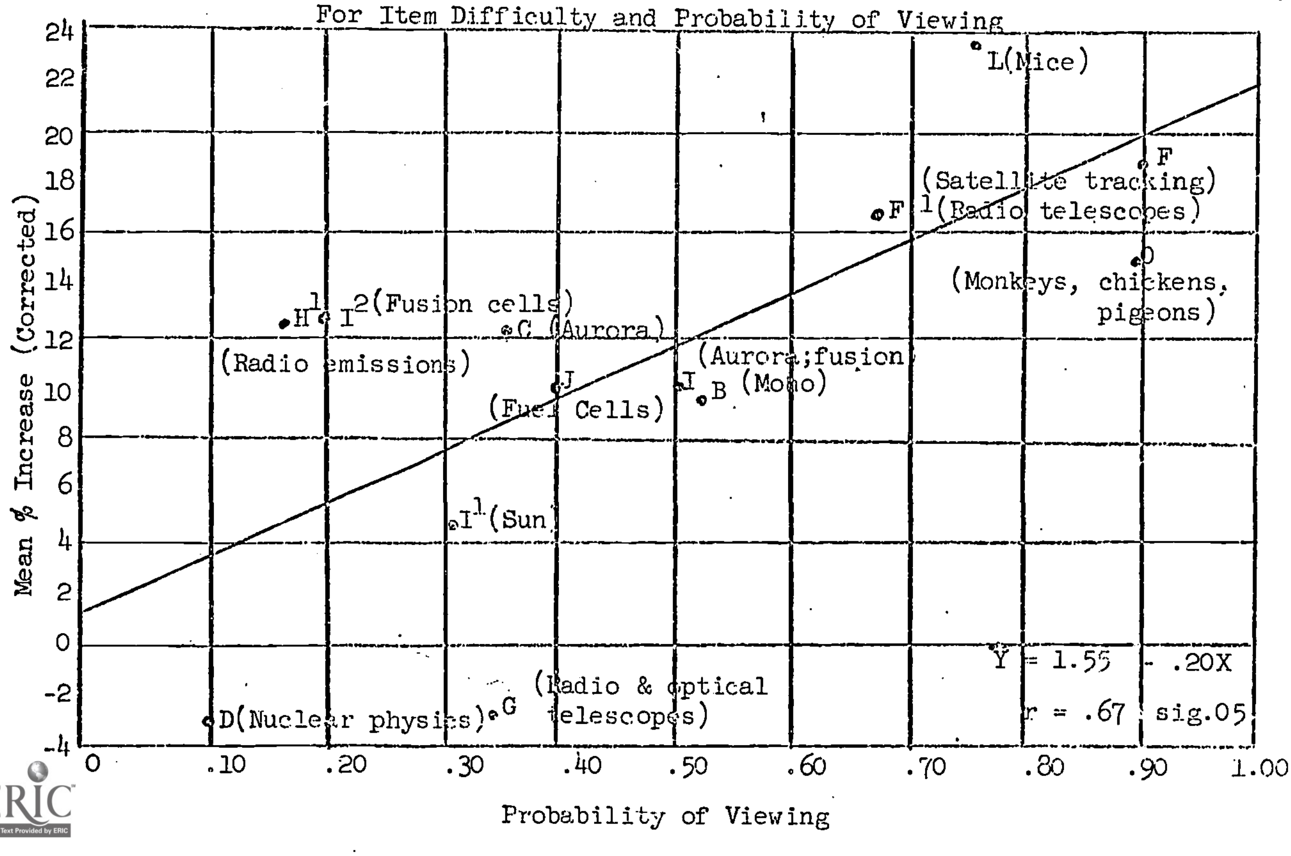


Table 7:7

Probability of Viewing Certain Display Areas of Hall IV

Alphabetic Designation	Description of Exhibits	Probability of Viewing
A^3	Map of Hall IV	.90
B	Inside the Earth: Moho	.54
C	Diamonds; Cuss I	.36
C^1	Aurora	.40
D	Nuclear Physics	.10
E	Project Transit: Entrance	.72
F	Satellite Tracking Station	.90
F^1	Radio Telescopes	.68
G	Radio and Optical Telescopes	.34
G^1	Optical Telescopes; All Sky Camera	.51
H		.34
H^1	Radio Emission	.17
H^2		.00
I	Aurora; Fusion	.51
I^1	The Sun	.31
I^2	Fusion Fuels	.20
J	Fuel Cells	.40
J^1		.20
J^2		.20
K	Biological Laboratory	1.00
K^1		.60
K^2		.40
L	Mice	.75
M	Nerve Growth Factor	.40
M^1	Electron Microscope	.25
O	Monkeys, Chickens, and Pigeons	.90

marked D, the exhibits on Nuclear Physics, deviates greatly from the estimate of its position based on regression--less was learned there than we would have anticipated. The same appears to be true for points G, the exhibits on radio and optical telescopes, and F, the satellite tracking station. For the exhibits on Nuclear Physics this extreme deviation may be due to the highly abstract nature of the subject, and perhaps to its relative unfamiliarity. The same may be true for the exhibits of radio and optical telescopes, though the departure from expectation did not appear in any of the preceding methods of analysis.

The satellite tracking exhibit, on the other hand, was a "live" exhibit, and preliminary examination led us to believe that it would be highly effective. The Behavioral exhibits, the point marked C, do not show such strong deviations, thus indicating that some particular feature of the satellite tracking exhibit reduced its effectiveness. Could the crowds themselves, have "gotten in each others' way," reducing the display's effectiveness? Probably not, since crowds as large were attracted by the Behavioral exhibits, and these show retention slightly above expectation.

The reader will recall that the items on the tests were not of equal difficulty. Given this situation it would appear that a small amount of change occurring on a difficult item should be of greater importance than a similar amount of change occurring on an easy item. Thus conclusions drawn from Figure 7:1 represent average change without consideration of item difficulty. Finer analysis of the relation between probability of viewing and change in probability of correct response can be made by weighting the changes on items in accordance with the over-all difficulty of that item.

Figure 7:2 shows the relationship between probability of viewing and mean per cent increase when the per cent increase has been corrected for item difficulty. The correlation for this scattergram is .67, significant at the 5 per cent level. Examination of this scattergram in relation to the preceding one points out some interesting differences.

The point marked O, the Behavioral exhibits, and the point marked I^1, exhibits concerning the sun, have dropped below the expectation based on the least squares regression line. Point F, the satellite tracking station, while still below expectation, is only slightly off. Points D and G remain far below expectation, but it should be noted that consideration of difficulty lowers point G relative to D. Points L, H^1, and I^2 are noticeably above expectation.

<u>Proposition 7:8 While probability of viewing seems definitely related to information retention, it is by no means completely explanatory of the retention.</u>

Examination of the scattergrams and the correlation coefficients associated with them indicates that, with or without correction according to item difficulty, only about fifty per cent of the variation in item changes is explained by variation in probability of viewing related exhibits. Additionally, the use of live exhibits is not enough to explain the observed deviations, since points O, F, and L all contain live exhibits. Accordingly neither the presence of movement, sound, high degrees of abstraction, or other of the mentioned characteristics seems alone to completely account for variations in retention.

Proposition 7:9 The effective communication of information by exhibits depends on the interaction of crowd flow patterns, use of life or movement in exhibits, and degrees of abstraction or familiarity in information presentation.

The above proposition seems to indicate the conclusions to be drawn from the examination of information retention in Hall IV. It has been pointed out that crowd flow patterns, as reflected in the probability of an exhibit area being viewed, are a major factor. The chapter on crowd flow indicates that large crowds, on the other hand, may limit the possibility of retention while the probability of viewing remains quite high. The presence of "live" characteristics or of movement in an exhibit may increase the probability of an exhibit being viewed, but may, in itself, serve as a distraction. Also live and moving exhibits may be limited in the degree of abstraction they can effectively communicate; witness for example the ineffective communication of the exhibits on Nuclear Physics.

Of the several exhibit variables discussed here, it would appear that the most important is crowd flow, and the probability of viewing. More retention seems explained by this variable than by any single other. This is not surprising--how, after all, could one learn from an exhibit one has not seen? Any realistic attempt to communicate via an exhibit must, however, take all these variables into account since they act simultaneously on the audiance.

Exactl, how these variables interact in specific displays cannot as yet be determined; the present discussion is based only on preliminary analysis. It is hoped that more conclusive information may soon be available in the form of a dissertation and various publications.

Conclusions

A certain caution seems advisable in drawing conclusions from this chapter. After all, it is likely that many kinds of exhibits can effectively communicate information, especially if one is interested in learning from them. Interviewers occasionally came in contact with persons who had spent hours, and sometimes days, in Hall IV trying to learn from the exhibits. For them, all kinds of displays provided an educational experience.

The data reported here does not refer to these rare visitors. The data come from the average visitor to Hall IV, not the exceptions. The point then is that only certain types of exhibits could effectively communicate to these average visitors and that the amount of information retained was quite small. How much retention occurred with the rare visitors is impossible to determine since the sampling method was in no way geared to seek out these people--although later analysis might clarify what happened to the occasional "serious viewer."

It is essential to keep in mind, while interpreting these results, that the crowd was, in general a fair crowd. The fair atmosphere certainly effected their tendency to retain information. Without additional information it is impossible to generalize the results of this analysis to situations other than a fair situation on any other than hypothetical grounds.

In Brief:

1. The present chapter gives preliminary findings on information retention in Hall IV: more complete analysis will be forthcoming in a doctoral dissertation by A. Dorius.

2. When analyzed in terms of content areas, five of the eight subtests showed small but significant increases in the percentage of correct answers.

3. The greatest information retention occurred to "Behavior" and "Applied Physics," both containing "live" exhibits.

4. When individual items (rather than subscale scores) were examined, the majority of those items showing significant change were associated with one of the three "landmark" exhibits: the Satellite Tracking Station, the Biological Laboratory, and the Behavior Section.

5. Items located along the paths of main crowd flow were more likely to show significant change.

6. Movement and sound tended to be present in items which showed significant increase in correct answers.

7. Exhibits which were most often picked as being "enjoyed" were also the ones for which the greatest information retention occurred.

8. The probability of a display being viewed correlated .72 with the average amount of information retained from that display.

9. In interpreting these findings, it should be remembered that the average fairgoer was in a holiday mood, and not interested in a serious and prolonged study of the exhibits. Our data give little information on the effectiveness of displays in educational-museum settings, or among people who are intent on learning.

CHAPTER VIII

THE ATTENDANCE STUDY

Otto N. Larsen

Problem

This chapter reports a study of audience attendance patterns at the United States Science Pavilion undertaken to determine: (1) the size of the Pavilion audience as compared to the total fair attendance by days, (2) the hourly, daily, and weekly audience flow in and out of the Pavilion, and (3) the audience flow by particular entrances and exits.

Procedure

A count was taken of every person, Pavilion employees excluded, who entered and left the Pavilion by the public entrances between 9 a.m. and 9 p.m. for one week from Monday July 23, through Sunday July 29, 1962. This time period was the first full week in the second-half of the Seattle World's Fair.

Each day was divided into six counting periods of two hours each. Three observers were employed during each counting period. One observer was stationed at the main stairway going up to the first exhibit hall. The other two observers were stationed at the left and right stairways going down to the level of the direct outside exits and entrances of the four remaining exhibit halls. A person was counted as entering or leaving the Pavilion as he passed the main platform on each of these stairways.

The observers used a mechanical recording device for counting persons entering the Pavilion. As persons left the Pavilion the observers made a tally mark on a record sheet. The total number of entrances and exits were posted for every two-hour period up to 9 p.m. each day. Since the Pavilion does not close until 10 p.m., the number of entrances and exits does not balance for each day of the observation period. The bulk of the difference probably represents people who have not departed from the Pavilion by 9 p.m. However, some of the difference may also represent errors in counting. In general, the reliability of counting entrances is believed to be higher than the reliability in counting exits from the Pavilion.

The simple procedures employed in this study limit the finding to certain observations about audience size and movement.

Findings

Fair Attendance and Pavilion Entrances The average daily attendance at the fair during the week in question was 51,942. The average number of daily entrances to the Science Pavilion for that same period was 36,151 or 69.6 per cent of the average daily fair attendance. As indicated in Table 8:1, the number of persons who enter the Pavilion represents a fairly consistent proportion of the daily fair attendance.

Table 8:1

Fair Attendance and Science Pavilion Entrances,

July 23 - July 29, 1962

Day	Fair Attendance	Pavilion Entrances	Per Cent
Monday	54,067	37,251	68.9
Tuesday	58,278	42,522	73.0
Wednesday	56,518	40,348	71.4
Thursday	52,927	36,987	69.9
Friday	46,889	32,065	68.4
Saturday	49,733	32,223	64.8
Sunday	45,184	31,661	70.1
Totals	363,596	253,057	69.6
Daily Average	51,942	36,151	69.6

The present data suggest that high and low fair attendance does not appear to significantly affect the proportion of fair-goers who enter the Science Pavilion. Fair attendance was highest during the first four days of the week and lowest during the last three days, with the range extending from approximately 45 to 58 thousand persons. Despite this variation, the proportion of entrances to the Science Pavilion was fairly consistent on both high and low crowd days at the fair.

This consistency provides a basis for estimating the total number of <u>entrances</u> but not the total number of different persons coming to the Pavilion during the fair. For example, the data from the present study suggest that if total fair attendance reaches nine million persons then the number of entrances to the Science Pavilion would be 6.3 million persons. Caution must be exercised in interpreting such estimates, however. Duplicate appearances by the same person at the Pavilion on a given day must be taken into account. Whereas fair attendance figures for a given day do not include any duplicate count of persons, the count of Science Pavilion entrances does include duplications. Some people enter the Pavilion, exit, and then return again later on the same day. Some people go up the main stairs, turn around, and then go down one of the other stairs to the lower level. In such cases, these persons were counted each time they entered and exited. No accurate record of duplications could be made using the counting procedure of this study. In the judgment of the observers, duplication would not reduce the proportion that the Pavilion entrances are of the total fair entrances for a given day to less than one-half. The suggestion then is that Pavilion entrances represent a minimum of 50 per cent and a maximum of 70 per cent of the fair-goers for any given day.

<u>Hourly Entrance Patterns</u> Table 8:2 shows that the audience flow into the Pavilion by two-hour periods was strikingly consistent from day to day during the week. By one o'clock about one-third, by three o'clock about one-half, and by five o'clock about three-fourths of each day's crowd had entered the Pavilion. For given hours of the day the Pavilion seems to attract persons in a fairly constant way from day to day even with some variation in the number of persons on the fairgrounds. The present study does not throw any light on what crowd control factors contribute to the pushes and pulls that result in this pattern.

Table 8:2

Cumulative Per Cent of Entrances to Pavilion
by Two-Hour Periods for Each Day of the Week

Hours	Mon.	Tues.	Wed.	DAY Thurs.	Fri.	Sat.	Sun.
				Cum. Per Cent			
9-11	8.2	11.7	11.2	11.1	11.2	11.3	11.8
11-1	31.2	28.7	28.3	27.8	30.6	29.8	30.8
1-3	54.9	48.3	50.6	52.1	53.2	53.4	51.5
3-5	73.4	73.2	73.2	75.2	75.7	74.3	73.7
5-7	87.2	86.6	88.6	88.0	88.6	87.4	89.1
7-9	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total N	37,251	42,522	40,348	36,987	32,065	32,223	31,661

Entrance Routes A person approaching the Science Pavilion can either go up the center stairway to the first exhibit hall--The House of Science--or down the left or right stairways that lead to the later exhibit halls. For first visits, at least, the former route is presumably the appropriate one since the first exhibit hall introduces the whole theme with a film on the growth of science. Since there are often lines waiting to enter the House of Science, the crowd itself serves as a check on the number of persons who select a particular route to enter the Pavilion. The routes of entry by day of the week are presented in Table 8:3. The major deviation from a fairly consistent day to day pattern of Pavilion entry is found on Tuesday, the day with the highest attendance, which was the only day when less than half of the entrances were made by the stairway leading to the first exhibit hall. The relatively low percentage of entrances by the left stairway is accounted for by the fact that this is the principal route for exits.

Table 8:3

Routes of Entry to the Science Pavilion

Entry Stairway	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.
	Day of the Week						
Center	60.9	46.5	57.6	54.0	57.9	58.3	63.5
Right	25.7	41.9	30.3	30.7	28.8	30.5	26.1
Left	13.4	11.6	12.1	15.3	13.3	11.2	10.4
Total Per Cent	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total N	37,251	42,522	40,348	36,987	32,065	32,223	31,661

Exit Routes The left stairway (facing the Science Pavilion) is the major exit route. On six out of seven days nearly three-fourths of the persons leaving the building left by that route. The one exception was Tuesday, the day with the highest attendance, when only about two-thirds of the exits were by this route. Nearly one-third of the total departures on Tuesday were via the center stairway. This suggests that as fair attendance begins to approach 60 thousand and Pavilion entrances begin to exceed 40 thousand persons on a given day then there will be a marked shift in the entrance and exit routes at the Pavilion. Crowd pressures on those days indicate that a large number of persons walk up to enter the Pavilion by going first into the House of Science but they do not wait to follow that route. The pattern of exits is indicated in Table 8:4.

Hourly Net Attendance in Pavilion How many persons are in the Science Pavilion at a given time? Subtracting the cumulative number of persons leaving from the cumulative number of persons entering at a given time period can provide some answer to this question. The data are presented in Table 8:5.

Table 8:4

Exit Routes from the Science Pavilion

Exit Stairway	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.
	Day of the Week						
	Per Cent						
Left	74.5	61.7	76.2	78.5	76.8	75.7	75.0
Center	19.5	32.9	16.4	14.7	16.7	17.8	18.9
Right	6.0	5.4	7.4	6.8	6.5	6.5	6.1
Total Per Cent	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total N leaving	34,493	39,101	36,517	33,363	30,362	30,131	31,109

Table 8:5

Number of Persons in Science Pavilion by Hours and Days

Hours	Mon.	Tues	Wed.	Thurs.	Fri.	Sat.	Sun.
	Day of the Week						
	Net Number in Pavilion						
9-11	2,411	4,182	3,893	3,563	3,076	3,045	3,008
11-1	5,222	4,780	4,215	3,611	3,192	3,598	3,123
1-3	4,908	3,269	5,341	4,955	2,825	4,173	2,725
3-5	3,746	3,421	3,718	5,309	2,106	3,999	2,473
5-7	3,011	3,951	3,916	4,202	1,876	2,380	1,706
7-9	2,758	3,421	3,831	3,624	1,703	2,092	552

A Replication The study reported above gave an account of the number of persons who came to the Science Pavilion during the week July 23-July 29, 1962. This section presents the findings on the number of persons who entered the Science Pavilion on Friday, October 12 and Saturday, October 13, 1962. The procedures are as described earlier, the results are shown in Table 8:6.

Table 8:6

Cumulative Per Cent of Entrances to Pavilion
by Two-Hour Periods, October 12 and October 13

Hours	Friday Number	Friday Cum. Per Cent	Saturday Number	Saturday Cum. Per Cent
10-12	4,910	19.3	7,488	16.6
12-2	6,045	43.0	9,538	37.7
2-4	5,623	65.1	11,671	63.5
4-6	3,954	80.6	8,347	82.0
6-8	4,946	100.0	8,150	100.0
Totals	25,478	100.0	45,194	100.0

Again, as in the initial attendance study, the figures above show that a fairly constant proportion of the daily attendance entered the Science Pavilion during a given two hour period even when there was considerable variation in the total number of persons attending in a given day.

The relationship of Science Pavilion entrances to the total daily paid fair attendance is shown in the following figures:

Day	Fair Attendance	Pavilion Entrances	Per Cent
Friday	40,724	25,478	63
Saturday	75,631	45,194	60

Again, as in the earlier study of entrances to the Science Pavilion, the variation in the number of persons attending the fair on a given day does not appear to significantly affect the proportion of pavilion entrances. However, this proportion is about seven to ten per cent lower than the average during the earlier count which was taken at about the mid-point of the fair. This may result from a difference in fair attendance patterns; the October crowd perhaps containing a larger portion of repeat visitors.

In Brief

1. A count was taken of all people who entered and departed from the Science Pavilion during one week in July, between 9 a.m. and 9 p.m.

2. In any day, on the average, 69.6 per cent of the people on the fairgrounds visited the Pavilion. This figure was fairly constant, ranging from 64.8 per cent to 73.0 per cent.

3. It is suggested that these figures be interpreted with due regard for their limitations, since people can come several times to the Fair and enter the Science Pavilion but once; it is also probable that many people entered the Science Pavilion more than once in a single day.

4. Hourly attendance patterns were highly stable from day to day.

5. Between 46.5 per cent and 63.5 per cent began their visit by the entrance leading to Hall I, the "House of Science" film. The rest entered stairways leading to the latter part of the complex.

6. It is suggested that as entrances exceed 40 thousand persons per day, crowd pressure forces people away from the main entrance, and into starting with later exhibitions.

7. A replication of this study was conducted for a two-day period in October. The percentage of entrances to total paid Fair attendance had diminished, being 61.5 per cent. This may possibly reflect a greater proportion of Fair visitors who have already seen the Pavilion, and wish to visit displays with lower priority.

CHAPTER IX

CROWD FLOW PATTERNS IN HALL FOUR

Allan Dorius

Full interpretation of the crowd flow patterns in the Science Pavilion awaits later analysis; the present chapter presents some early and general findings.

Procedure

Essentially what was involved was this: hiring people to watch crowd flow would have proved prohibitively expensive during the six months the Fair lasted. Therefore it was decided to employ time-lapse photography, with cameras focused on various exhibit areas or vistas in order to observe (presumably with less bias) the direction of traffic flow and/or total number of persons viewing an exhibit at any given time. Time-lapse photographs had an additional advantage over human observers; they provided a complete and permanent record which could be later used to check a variety of hypotheses.

Equipment consisted of three 16 mm Bolex H cameras, fitted with modified continuous run motors and with electric clocks which activated the motor and allowed one frame to be exposed approximately every 12-15 seconds.[1] This system never achieved the reliability anticipated in part due to equipment failure and in part to variations in electrical output from the wall socket. As a result, exposure time-lengths were variable. Persons contemplating such devices are welcome to write to the author for comments gained from e perience.

Briefly, the procedure was as follows. The cameras were changed with fresh film daily, usually in the morning. The newly exposed films

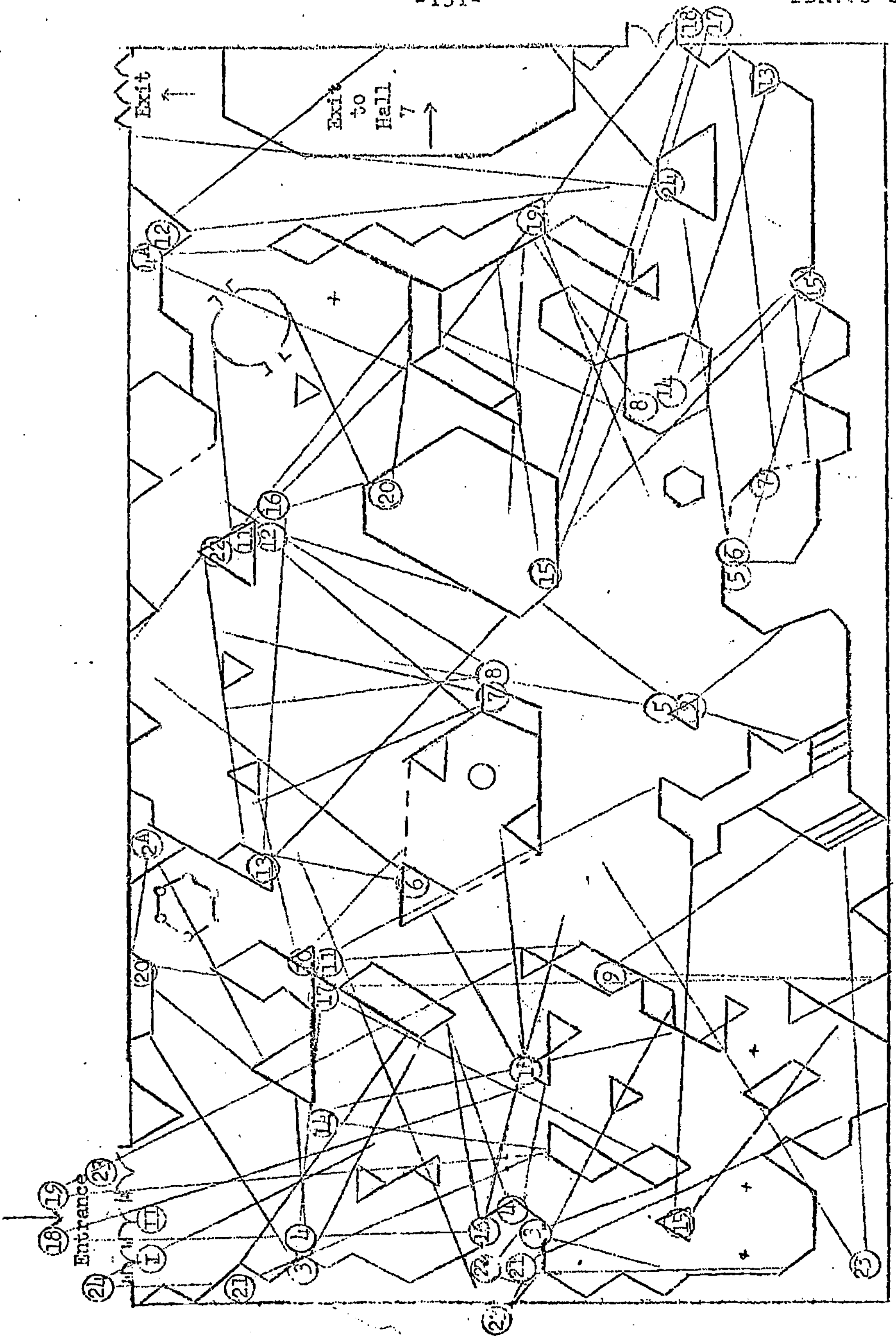
1. The motor used was Bolex type MC17; the electric timing attachment was supplied by Stevens Engineering Company, California. Super Hypan Ansco reversal film was employed.

were developed by the next afternoon. Should a film prove poorly exposed, or should some component of the equipment malfunction, the camera was returned to its former position for another day's run. This resulted in some duplication, but in fact proved useful as a check against those parts of earlier films which could be defined. Beginning at the main entrance to Hall IV of the Science Pavilion, the entire area of the Hall was photographed. When minimal coverage was achieved, different angles on similar areas were tried, providing yet a further check which greatly assisted analysis and interpretation.

Typically, at least two cameras were working, and the second was set in a position complimentary to the first; say, on the entrance and exit of an exhibit or exhibit series. All camera mechanisms were connected to the display electrical system, turning off with the exhibit lights at night and on in the morning, thus allowing the 100 foot film roll to last for over 24 hours. Cameras were placed at three height levels, depending on the accessibility of the module and the particular vista desired. The eight foot level gave clearest shots but the camera attracted occasional attention. The fourteen foot level proved best over-all, giving a good vista but still allowing count. The thirty foot level functioned as a check, an over-view, which allowed the viewer a longer look at the patterning of people. Figure 9:1 shows the positions of the camera (similar numbers indicate two cameras functioning on the same day) and the range of view and over-lap of the vistas. It is apparent that most of the floor at one time or another was observed.

Analysis

The films were daily viewed and catalogued. As an added precaution,



Position of Cameras and Range of View in Hall IV

Figure 9:1

the investigator began each film by photographing a sign showing the time of day and the area covered; thus errors in cataloguing could be detected and not interfere with analysis.

Since the time-between-pictures varied from camera to camera, and even varied in the same camera, split second timing was unfortunately lost and dropped from analysis. An estimate of a given person's time-spent-in-viewing however was roughly approximated.

This initial analysis of the films, some 50 in all, was done by the writer with at least one and sometimes three judges assisting and offering comments or contradictions. Judges were provided with maps of the floor plan and told of the vista they would be viewing. All were familiar with the interior of the building and no trouble was encountered recognizing the exhibit area. Their task was to closely examine the time-lapse photography and indicate the general movement of people in, around, and through the exhibit-complex. The films were viewed with a Bell & Howell Analyst projecter making possible various viewing speeds, from stop-frame to normal. A frame counter allowed for return checks to any point in the film. At the conclusion of a given film, the judgments of crowd flow-patterns were checked, and if disagreement existed, another viewing was undertaken. Since this type of viewing results in considerable screen flashing, frequent pauses were necessary, making the job somewhat tedious. It is noteworthy that remarkably similar flow-patterns were obtained.

At least three times during the run of a film, the camera was stopped and head-count of both total number of people in picture and number of persons watching any given exhibit during an hour period was recorded. This was done typically at the beginning of the film, the middle, and the end, unless unusual activity was noticed which required further examination. The film was stopped at a given frame, five frames later stopped again, and so on until fifty frames covering approximately one hour in time had been counted. The numbers were then averaged giving a mean count for persons in the area and at any given exhibit in view. This was again done in the middle and near the end of the film. It was felt that the unreliability of constant time between exposures would provide a sufficiently random count, thus avoiding any pulsing which might escape detection should it fall consistently on one of the "between" frames. Disagreement on counts or averages was rare. It must be acknowledged that, due to the general darkness of the building an accurate count was impossible in heavily concentrated areas, even with elevated lighting--but with time the judges could fairly well estimate how many people a given area could contain.

Perhaps the most meaningful analysis resulted with the use of relative flow ratio, hereafter abbreviated as the RFR. It works as follows: At any given choice point, a crowd of four or five people would split, the majority moving in one direction, with one or two going another. When head-count was made, attention was given to the following ten frames or so, to determine which direction the persons in view traveled. While the comparatively long time duration allowed many to be out of sight by the following frame, some indication of main and subsidiary traffic patterns could be estimated. Thus, when consensually validated, one might state that from Choice Point Z, three went to the right, two to the left, in the "average group" of five people.

Major Influences on Crowd Flow

A film by film analysis has been made and will be published as part of a dissertation. In the present report we shall confine ourselves to the general traffic patterns and highlights of the analysis, making specific comments only where necessary.

From the beginning many crowd flow patterns were obvious. These patterns depended not on specific exhibits, but rather on interplay between exhibits. To ignore these larger patterns, and concentrate only on single exhibits, is akin to not seeing the forest for the proverbial trees. The first part of this discussion, then concerns general patterns of crowd flow.

There were several factors which influenced the probability that an exhibit would be seen. Hall IV was subject to a "pulse" effect, resulting from the conclusion of the "trip through Space" show in the adjoining building. While many persons did enter at other times, at all camera stations this pulse could be detected. Thus its influence reached to the farthest corners of the building, and was detectible long after the crowd had left the Spacearium. Its significance is not to be under-rated, for besides affecting the rate of flow, it affected the total flow pattern and even the probability of a given exhibit being viewed.

Very early in film analysis, in fact on the first films, it was noticed that persons entering the main doors, marked Entrance on Figure 9:2, would view more leisurely the exhibits marked A' and D' if a pulse was not in effect. Crowds entering here could choose three avenues of travel, but seemingly the inertia of the pulse pushed them straight to and around the Barrier marked A^3.

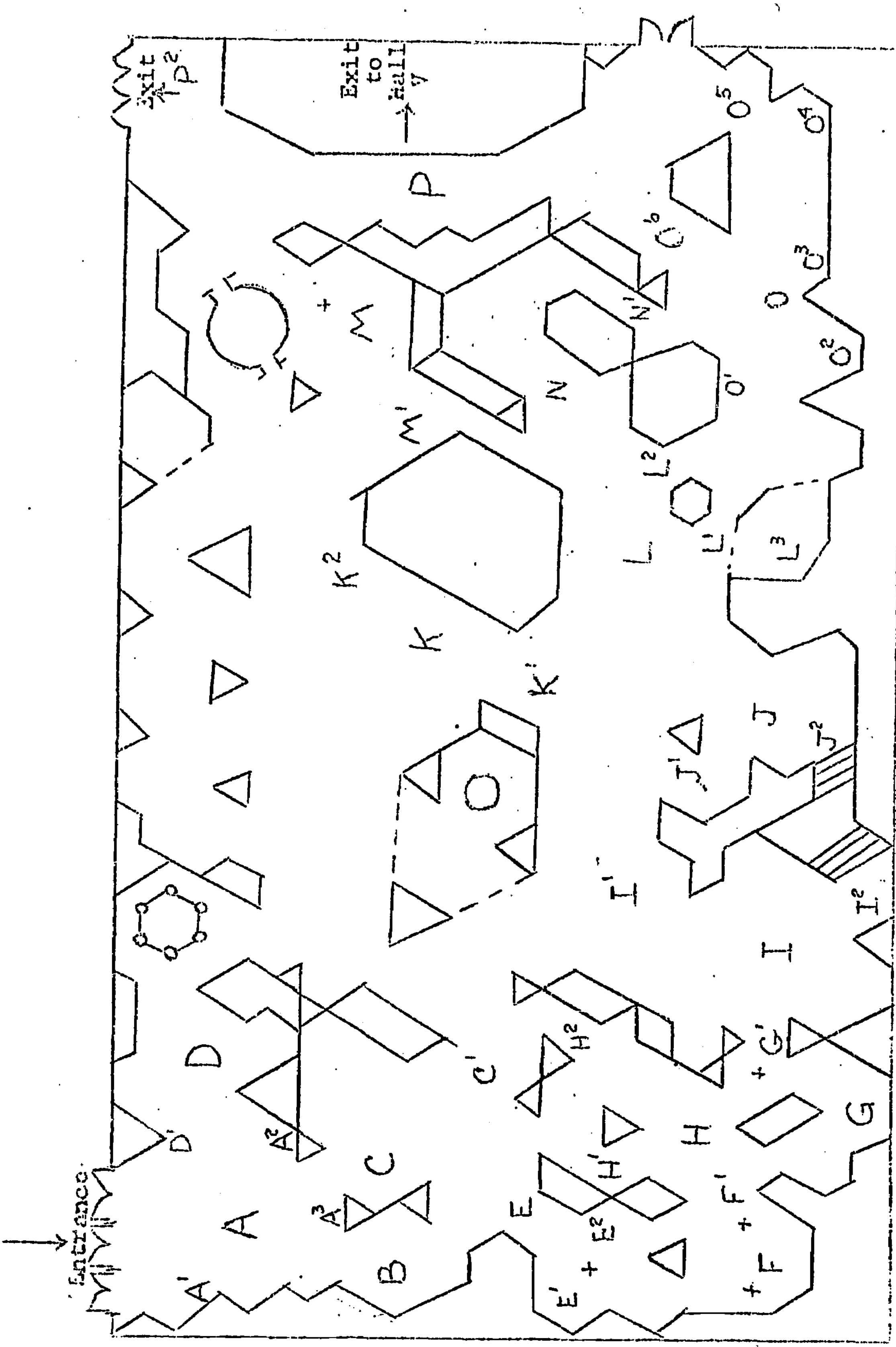


Figure 9:2

Major Exhibit Areas in Hall IV

A map of the inside of the building was placed directly in front of the entrance, but only during slack times was it ever consulted. This proved also to be true of the aforementioned exhibits. It thus appears that one of the variables affecting exhibit viewing is sheer number of people in the surround.

A second major influence, affecting crowd flow through the entire hall, was set up by a single exhibit. While the investigators expected some interaction from one exhibit to another, it was not anticipated that main traffic patterns could be literally determined by a single exhibit, or that crowd flow through one half of the building would be dominated by it. This highly influential exhibit was the Satellite Tracking Station (exhibit F in Figure 9:2), a complex array of computers, oscilloscopes, and satellite models which contained one further essential element: a human narrator with a microphone.

In an area designed to break up crowds and get rid of the "pulse" effect of the space show, here was an exhibit fairly early in the building that attracted a large crowd and upon completion created the pulse all over again. The film records show that time after time it would pull people away from surrounding exhibits, and sometimes seemingly "prevent" some exhibits from being viewed. The investigators have no doubt that, with its removal, the entire course of the main traffic pattern would have been unmistakably altered.

A third major variable, and again one causing a pulse where none was expected, was the experimental laboratory (K in Figure 9:2) which, besides occupying such a prominent position in the building that it could not fail to be seen, contained from three to six persons, who periodically gave lectures to the crowds. The laboratory's influence on the latter half of the buildings exhibits cannot be over-stressed, for here again it seemed to determine just what would be viewed in the building.

The final major variable influencing crowd flow was the section on the behavioral sciences (marked O in Figure9:2). This section, containing pigeons, monkeys and their mothers, baby chicks being hatched, and salmon, was the only exhibit that achieved much notoriety outside the Science Pavilion, and many a guide was asked simply "Where are the animals?".

With the exception of the first variable, the pulse from the Spacearium, all major exhibits seemed to act as "landmarks." To "see" building IV meant to at least see these three exhibits, as to "see" Paris means to see the Eiffel tower and the Louvre. Once one has seen the Eiffel tower and the Louvre, then one can go on and see other things, but it is impossible to "see" Paris without seeing them. Similarly, to see Building IV means to see these three exhibits, and only later to see other things. In fact, there was evidence that the monkey exhibit was a "landmark" for the entire Science Pavilion.

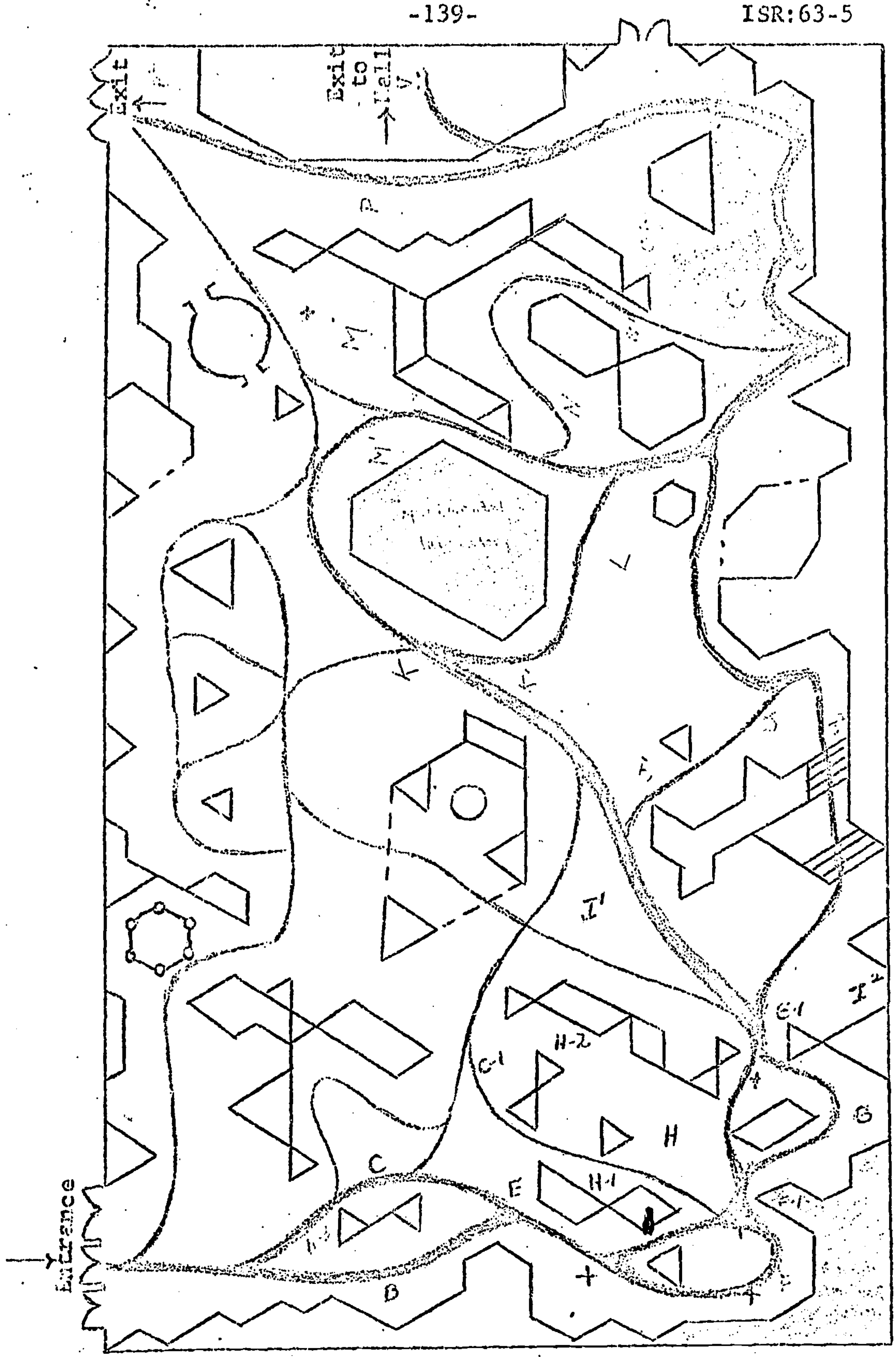
With these considerations in mind, the main traffic pattern gains considerable logic, for it is obviously influenced by the three exhibits, as well as the main "pulse" from Area III - the Space show. It was deduced from the combining of all maps used by the judges and was checked several times for consistency.

Main Traffic Patterns

Figure 9:3 illustrates the main patterns of crowd flow. With few exceptions, the majority of people entered the main entrance of Hall IV. The majority went straight to the Barrier A^3, only one in ten taking avenue D. Relative-flow-ratio (RFR) at this point was most interesting, and varied considerably, depending on whether the person was in a main pulse. Assuming he was, RFR for the point showed that of 5 persons, three would enter B and two would enter C. The number of people in area C varied, sometimes becoming too thick to count because of the size of the crowd exiting from the Spacearium. Later films of the same area disclosed the early interaction of surround variables and the necessity for integrating the film records. The "pulsing" started about 10:30 a.m., and continued at 20 minute cycles during the day, which coincided with Spacearium showings. During a pulse, Area B would finally fill-up (saturate), literally blocking the path of persons at point A^3, and forcing them around into C, thus increasing the probability that this exhibit (on Diamonds) would be viewed.

Flow around the Barrier, A^3, was complex. Several film records supported the conclusion that virtually all of persons leaving B went to E, but also of the two persons in C, one of these would also enter at point E, thus of the original 5, 4 were now back together.

High angle photographic records determined the following. The persons in the surround would quit their exhibits and enter the satellite tracking station area as soon as a lecture started. In fact, unless a long wait was anticipate, most persons were there already.



Major Crowd Flow Patterns in Hall IV

Figure 9:3

At point F^1, the majority were confronted with another "main" barrier which neatly divided them in two; of four persons at point F^1, 2 would enter G and two would enter H. The two going to the "right", i.e., G, would invariably exit point G^1. Of the two persons at point H, one would exit up through H^1 to C^1, the other would exit G^1, rejoining main traffic flow. And here is an excellent example of missed exhibit- virtually no one, no matter what his starting point, would exit H^2. Many angles on the same area (films 14, 17, 18, 19, 23, etc.) revealed no one in the area H^2, although investigators paid special attention to it. It was simply outside of the main and secondary traffic flow and might just as well not have existed.

At point G^1, the long range effects of the Satellite tracking station are most evident. Films 9, 11, 19 showed that a pulse from the satellite station modified exiting behavior. When a lecture from the Station had terminated, the main crowds would fill area I, and of five people, 4 would exit I^1, one would exit I^2 (up the stairs), apparently the former offering a larger avenue of escape. But when a lecture had not recently finished, and the regular crowd was meandering through, the split would be more like fifty/fifty; if anything a slight tendency for more persons to go through I^2 - the opposite of pulse behavior. The area itself is given only cursory attention by the majority of viewers, average viewing time usually being under one minute for the entire area.

Cameras viewing area J, disclosed about as many entered via J^1 as down the stairs through J^2. Head count showed the influence here too of the pulse from the satellite tracking exhibit; i.e., when hit by the pulse, area J contained 15-20 people, but at other times it averaged only 10. Since we know many more people were in the building at the time, we could safely assume many, perhaps half, were bypassing this area.

Whether from I^1, or from area J, camera placements 5, 10, 12, 13, 19 all demonstrate that persons then entered K--the Biological Laboratories. If a lecture was NOT ON, they would exit to K^1 (in effect backing out) and continue on to L. If a lecture WAS ON, or would start in a minute or two, their later exiting behavior grew highly complex.

During a lecture, the behavior of the crowds was quite difficult to assess. To begin with, the exhibit was very large--the largest single exhibit in the building. Furthermore, the viewing area allowed a considerable number of people to congregate. Since the laboratory attendents were all young girls and the space was well lighted, even the appearence of the girls came into play, the prettier girls drawing larger crowds.

Secondly, the exhibit "stacked" considerably. That is, the size of the exhibit permitted effective viewing by many people, the exhibit averaging 40 per lecture. But a curious finding resulted from close scrutiny of the crowd behavior. When more people stopped than the exhibit would effectively "hold", the back rows became quite mobile. This complemented other displays in the area by leading the "excess" people around the periphery to another exhibit they could "have to themselves."

Perhaps the most interesting finding was so subtle as to escape detection in the first showings, although it was obviously in operation. The judges noticed that some variable that they couldn't ascertain influenced the crowds exiting from the biological laboratory, sometimes breaking it in half around both sides after a lecture, sometimes pulling it to one side or the other. After several viewings (which shows the advantages of time-lapse films as opposed to in-person viewing) the cause became clear; the dispersing direction was due to the location of the female lecturer at the end of her talk. If she finished her lecture on the K^1 end of the lab, the crowd filed out into area L. On the other hand, if she concluded her lecture at the K^2 end, they would tend to pass around that side of the lab, - entering into area M. This even was apparent when the lecture terminated in the middle of the lab, for then the crowd seemed to split itself fairly evenly, one half passing around one side, the other moving just the opposite.

Such a curiously subtle effect, which apparently the lab lecturers were not conscious of, shows how difficult and abstruse the interrelationships between exhibits in a pavilion or museum can be. Area M, largely removed from the main crowd flow, could enter into the "main stream" by the capricious decision of a lecturer when she ended her address.

In any event, the majority of persons returned to Area L, either through "backing out" to K^1, or entering the area through the "chute" behind the lab- M^1. Occasionally a lab pulse would coincide with a satellite pulse, thus jamming area L to capacity and driving persons in area K, even when no lecture was in progress. Typically, crowds split fairly evenly arou ' the mice exhibit and entered area O a steady flow. But here again the interplay of many factors could operate, causing crowd flow diversion. If the lab lecture ending did coincide with a large pulse coming from another area, the section marked L^2 would saturate first, followed quickly by L^1. This would divert an unusually large number into area N, which would then enter area O by route N^1. If the stacking became great, area L would be completely blocked off, "forcing" persons into area K.

Whatever their path, most persons entered area O at one time or another. Films on the area (7, 14, 15a) revealed such heavy traffic that movement in the area was often virtually halted. In an area with relatively small display fronts, the appeal and/or reputation of the exhibits culminated in vast and continuous crowding, and extremely complex traffic analysis. Briefly, the major findings are as follows:

If area L was blocked off, some persons would gain entrance to area O through a relatively ignored exhibit, the salmon migration display - area L^3. In the main, however, it appeared that this exhibit was entered "backwards", due to heavy stacking in area O.

A typical view pattern was quite evident in area O, regardless of whether the crowd entered from L^1, L^2, or N^1. The crowd "began" its viewing at O^1 (the pigeons), crossed over the aisle to O^2 (the live chicks), stayed on the same side and viewed O^3 (the live monkey mothers and their offspring), O^4 (the surrogate mothers and their little monkeys) and then exited O^5. This was a most unfortunate viewing pattern. Excluding the pigeons and chicks, which could be entirely viewed from one position, the sub-area 0^3 and 0^4 was designed to be read just the opposite way from the way the crowd entered, text and explanation running from 0^5 to 0^4 to 0^3. In fact, the whole wall of displays made little sense when viewed any other way. While the charm of the animals attracted the greatest flow of people, only by opposing the heavy stream of traffic, could a person read the text of the display and get information from the exhibit. One might anticipate that although the area was virtually saturated at all times, little increment in knowledge was gained.

Exit behavior from this area, as shown on films 12 and 13, was largely through exit 0^5, RFR being 4 to 1 with 0^6. Here persons were faced with the final decision, which again had a capricious element.

To begin with, the entrance to Hall V was poorly marked, only gaining an inside sign during the second half of the Fair. Even so, the sign was almost undetectible from any distance. As a result, in spite of a steady flow of persons into P, the crowd did not continue to Hall V immediately, but rather meandered aimlessly. Where they went next was partly a matter of chance. To their left were four doors. In spite of the "Exit Only" signs on the other side of the door, and the "No Exit" on one of the inside doors, the traffic flow through the doorway was considerable. Persons would enter into Area IV from the outside walk, or finding doors leading apparently from the Area, would exit to the pool area. Each opening of the doors resulted in a flash. This flash was due to the relatively bright outside daylight reflecting off the buildings and pool and had the effect of catching the eye of the meandering person in Area P, drawing him to the doors. His exit in turn caused another flash which drew other people, and so on. If no exiting was going on through these doors (P^2), most of the persons sooner or later would enter into Area V through the main exit P^1. But the distracting flash caused by the doors occurred frequently, thus pulling fully half of the twenty or so persons usually in the area - RFR then being 50% either exit.

Conclusions

It seems obvious that the kinds of display interactions described above were taking place throughout the entire building. Even with such a quick analysis, the extremely complex relationship one exhibit will have with another, or with several others, seems quite clear. To assume, or even expect, that design engineers could be aware of all such interrelationships asks too much of their profession. However, in the successful design of the interior of such a building, such total patterning has overwhelming influence on how long an exhibit will be viewed or even <u>which</u> exhibits will be seen and thus creates an important, if heretofore ignored, variable. With further knowledge, it seems probable that analysis can be removed from after-the-fact interpretation to a more functional predictive status which would greatly enhance the work of designers, and add to the body of science as a whole.

In Brief:

1. Crowd flow patterns throughout Hall IV were recorded with time-lapse motion picture equipment; films were taken over a three month period.

2. Each film was analyzed in terms of general crowd flow movement (an impressionistic judgement), in terms of total people viewing during three randomly selected hour periods, and in terms of the "relative flow ratio", showing the percentage of people choosing each of the possible exits from a display.

3. Four variables appeared to influence crowd flow through the entire Hall. These were: (a) the pulse which entered after each showing of the Spacearium film, (b) the pulsing effects set up by the schedule of demonstrations at the satellite tracking exhibit, (c) the pulsing effects set up by the lectures at the biological laboratory, and (d) the extreme interest aroused by the animal exhibits at the behavioral sciences section.

4. Analysis of crowd flow to specific exhibits showed the influence of the several pulsing effects; and further suggested that more specific patterns of crowd flow are predictable, but motivated by subtle considerations. Failure to anticipate such patterns can negate the educational effectiveness of individual exhibits.

Chapter X

GENERAL REACTIONS TO THE SCIENCE EXHIBIT: A SMALL SURVEY AND ITS FINDINGS

Lynn Blackwell

The preceding pages have reported studies of large samples, aimed at finding specific--but often very small--changes induced by the Science Pavilion. The present chapter reports a much smaller study, carried out October 17 and 19, to investigate the public's main over-all reactions to the Pavilion experience. A sample of 114 respondents, picked at random as they left the Science Exhibit complex, were asked where they had been, what they had seen, and what they liked and disliked about the pavilion. Our aim was not to find precise percentages for before-and-after comparisons, but rather to demarcate the major kinds of experiences that people reported.

The Questions and the Sample

The questions are shown in Table 10:1. They were selected in part because we felt the need for further information which we had not been able to ascertain earlier. We had hoped, for instance, that we might be able to trace crowd flow through the entire Pavilion, finding the time spent and the routes taken. Our resources being limited, we were able to do this only in Hall IV, using time-lapse cameras. Still, the crowd flow patterns throughout the rest of the Pavilion were important too; in lieu of better methods, we decided to ask a small sample of people where they had been, what they had seen, and how long it took them.

Such questions have several obvious limitations. They depend on the (often faulty) memory of respondents, rather than upon actual observation. Biases may operate; it is likely, for instance, that people will over-estimate the time they spent in the Pavilion--an effect reported to us by Weiss and Boutourline.[1] Even so, the data serve to give a rough idea of what happened.

Other questions were used which asked specifically about Hall IV: whether the respondent had visited it, how much time he had spent, and what he thought to be its "main purpose." Hall IV was ostensibly designed to show the methods of science, as they were used to solve important questions. As our main interviewing progressed, we had begun to wonder whether people actually learned about the scientific method from specific displays, and whether the general purpose of the hall was even apparent. The main survey would give us the data to see whether people actually developed a better understanding of the scientific method; but it also seemed worthwhile to see how many people realized that this was the underlying theme of Hall IV.

Still other questions attempted to probe more directly into what people felt about the exhibits, and about the Science Pavilion.

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1. Robert S. Weiss, Brandeis University, and Serge Boutourline, Exhibit Research, also were engaged in research at the Seattle World's Fair, sponsored by IBM.

Table 10:1

Questions Asked in Small Survey

1. Is this your first day at the fair? (If not) How many days have you spent here?

2. If you had never been here before and just had two hours to spend at the fair, what do you think you would go to see?

3. Is this your first visit to the Science Pavilion or have you been here before? (If before) How many times?

4. What did you see on this visit?

5. Do you recall how much time you spent in the Science Pavilion on this visit?

6. Were you able to spend some time in Area 4? About how long?

7. What do you think is the main purpose of this area?

8. Fine. Now for a more general question. What is your over-all impression of the Science Pavilion?

9. Is there anything in the Science Pavilion that you'd like to come back to see if you had time?

10. Is there anything else that you particularly liked about the Science Pavilion?

11. And what did you like least about the Science Pavilion?

One item ("If you had never been here before and just had two hours to spend at the fair, what do you think you would go to see?") tried to find the relative importance of the Science Exhibit to the total Fair experience.

Interviews were held on the exit walk-way, respondents being randomly selected as they left the area. Interviews were conducted in part by Lynn Blackwell, of the project staff, and partly by volunteer student assistants.[2]

One limitation on these findings needs to be mentioned. Since this survey was conducted in the last week of the fair, the crowd reactions and composition may have been unusual. Since it was then known to the public that the Science Pavilion was to remain open after the fair, this may have affected the amount of time spent in the Pavilion, how much was seen, and how much of the total Fair visit was spent there.

Results

The general conclusions from the survey are again reported as a series of propositions.

Proposition 10:1 Patterns of crowd flow were exceedingly varied, the minority of respondents seeing the total Pavilion.

One question asked: "What did you see on this visit?" Table 10:2 shows that there was no specific route taken through the Science Pavilion by the majority of visitors. Rather, a typical tour might

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2. We wish to express our appreciation to Miss Gretchen Hoyt, Miss Stephanie Kelly and Miss Allison Jensen for their help on this task.

begin almost anywhere in the Pavilion and perhaps include only one or two buildings.

Table 10:2

Travel Patterns in Pavilion

All of Science Pavilion	35%
All except Hall I	11%
Don't know or no response	17%
Second half (Areas IV and V)	6%
First half (Areas I, II and III)	5%

Other routes besides those shown in Table 10:2 were reported by smaller numbers of persons who skipped Hall III, Halls I and II, or Hall V. Five per cent mentioned seeing the Science Theatre and one person reported that she had come only to sit in the court and watch the fountains, apparently a regular pilgrimage for her.

A problem which seemed difficult to avoid was the suggestion of answers to the respondent while trying to identify where he had been in the Pavilion. The emerging visitor was typically quite tired and very uncertain as to whether he had been through one, six or sixteen buildings in the course of his tour (note the high "don't know" response). Attempts to clarify his recollection may have markedly influenced his answer.

Proposition 10:2. Relative to its complexity, little time was spent at the Pavilion by the typical visitor.

"Do you recall how much time you spent in the Science Pavilion on this visit?" This question produced the responses shown in Table 10:3.

Table 10:3

Time Spent in Pavilion

One-half to one hour	45%
One to two hours	38%
More than two hours	17%

Although eighty-three per cent spent up to two hours in the Pavilion, more than half that number spent one hour or less, certainly not enough time to have absorbed many of its complex offerings. Time reported ranged from one-half to four hours.

Proposition 10:3 Reactions to the Science Pavilion were strongly favorable, but marked by considerable vagueness.

The following question was asked: "What is your over-all impression of the Science Pavilion?" As represented in Table 10:4, the average person had few specific comments to make. It should be pointed out

Table 10:4

Over-all Impression of Science Pavilion

Favorable ("wonderful, very good, beautiful, awe-inspiring")	89%
Neutral or unfavorable ("can't understand it, too congested")	10%

that asking questions about the Science Pavilion within its grounds might well have given us many more favorable comments than would have been the case had we asked the question elsewhere. A further breakdown of the "favorable" comments is shown in Table 10:5.

Table 10:5

"Favorable" Comments About Science Pavilion

General approval ("Wonderful, very good")	61%
Mentioned Beauty or Architecture	14%
Expression of awe (overwhelming, breathtaking)	4%

Example of some specific comments: "It will interest younger people in science;" "Helps to associate science with the common person, brings them closer to science, encourages parents to give children science background."

<u>Proposition 10:4 Specific favorable comments tended to center around the two motion pictures (Hall I, "House of Science;" Hall III, "Spacearium"), the architecture, and Hall IV.</u>

Asked was: "Is there anything in the Science Pavilion that you'd like to come back to see if you had time?" Responses are shown in Table 10:6. Also mentioned were the Science Theatre, Hall II, the Pavilion buildings, the computer exhibit in Hall II, and the animal exhibits in Hall IV. Several persons wished to spend more time on their next visit.

Table 10:6

What Visitors Would Come Back to See in Science Pavilion

All of Science Pavilion	32%
Would not come back	13%
Hall III (Spacearium)	11%
Hall IV	8%
Hall I (House of Science Film)	4%

A second question asked: "Is there anything else that you particularly liked about the Science Pavilion?" Table 10:7 shows the responses to this question.

Table 10:7

Anything Else Visitors Particularly Liked About Science Pavilion

Nothing else	19%
Pavilion Buildings	16%
All of Science Pavilion	15%
Hall III (Spacearium)	12%
Hall I (House of Science film)	7%
Hall II	4%
Hall IV	4%
Animal exhibits in Hall IV	4%

Isolated comments singled out the Science Theatre, the Illusion Ramp, narration in the Biological Laboratory, and Hall V.

<u>Proposition 10:5 Specific negative comments tended to center around the displays, as being too difficult, and around the crowded conditions of viewing.</u>

The question asked here was: "And what did you like least about the Science Pavilion?" Although nearly half found no complaints, the rest cited specific problems as shown in Table 10:8. Isolated responses

Table 10:8

What Visitors Liked Least About Science Pavilion

Nothing liked least	48%
Could not understand ever thing	14%
Too crowded and rushed	6%
Waiting in line	4%

to this question included Hall V itself, its lighting and its revolving ramp; sitting on the floor; not enough demonstration; too much walking; couldn't hear everything (in one case with specific reference to the narration of the Spacearium); too superficial; open to weather; not allowed in children's area; too complicated in arrangement. Some comments centered on personal dislikes: seeing animals used in such circumstances, watching dissection in the biological laboratory, "don't care about this space business."

Proposition 10:6 The typical visitor spent relatively little time in Hall IV: few people saw it as communicating anything about the methods of science.

In response to the question, "Were you able to spend some time in Hall IV? About how long?", over half of the visitors reported that they had spent no more than one-half hour in Hall IV, a time certainly inadequate to investigate its complexities. These responses are shown in Table 10:9.

Table 10:9

Time Spent in Hall IV

Did not go through Hall IV	23%
Walked through (five to ten minutes)	15%
Fifteen to thirty minutes	47%
More than thirty minutes	8%

The second question asked: "What do you think is the main purpose of this Hall?" It brought the response shown in Table 10:10. The category titled "Educational" includes such things as, "to show how

Table 10:10

Perception of Main Purpose of Hall IV

Did not go through Hall IV	23%
How animals learn or are trained	15%
Educational	19%
Progress or Method Of Science	13%
(Specific mention of Method)	4%
Don't know	6%

life is," "what makes people tick," "make you think" as well as the actual response of "educational." The "Progress or Method of Science" category includes comments on the future of science, how it works, and its present progress. As shown in Table 10:10 responses which specifically mention the scientific method or experimental work (example: "shows how we are gaining our knowledge") were limited to four per cent. A wealth of interesting comments were gathered: "to show learning process," "insight in children's behavior" "to show fingers of science coming together to form the hand," "awaken people to wonder of science."

Again the problem of suggesting answers to the respondent must be considered. Most of those interviewed did not identify Hall IV by any such label. Even pointing to the building, recalling the "room with all the displays" or "the area following the Spacearium" did not always bring recollection. Sometimes it was necessary to describe Hall IV as the place where the biological laboratory or the animal exhibits were. At that point recognition began and the interviewer then emphasized that she was interested in the purpose of the <u>total</u> area, not of specific exhibits.

<u>Proposition 10:7 The Pavilion was most likely to be visited during the first or second trip to the Fair. Even repeat visitors to the Fair were likely to see the Science Pavilion only once or twice.</u>

The following questions were asked: "Is this your first day at the Fair? (If not) How many days have you spent here?" "Is this your first visit to the Science Pavilion or have you been here before? (If before) How many times?" Replies are shown in Table 10:11.

Table 10:11

Days Spent at Fair and at Science Pavilion

	Day at the Fair	Day at the Pavilion
First Day	44%	70%
Second Day	24%	22%
Third Day	10%	4%
Fourth Day	7%	1%
Fifth or more	16%	3%

Sixty-eight per cent of the sample were in their first or second day at the Fair. That the Science Pavilion tends to be seen only once is strongly suggested by the figures, the large majority (70 per cent) of visitors seeing it for the first time, even though many more could have made two or more visits. That thirty-two per cent of the sample had entered the Fair three or more times may reflect the many local visitors. No item asked the respondent's residence, but pertinent data is available from the main study, and by examination of the sample obtained during this last week of the Fair we may be able to estimate the proportion of local visitors in our sample.

Proposition 10:8 The Science Pavilion was rated above other Fairground attractions by the majority of Fair visitors.

In order to determine if the Science Pavilion was a "must see" exhibit at the Fair, respondents were asked: "If you had never been here before and just had two hours to spend at the Fair, what do you think you would go to see?" This question, posed as it was in the Science Pavilion, probably drew rather biased answers; subjects perhaps being willing to give the reply they felt the interviewer wanted.

Fifty-nine per cent of those interviewed said they would visit the Science Pavilion first. Fourteen per cent felt there would not be time to see anything, didn't know what they would see, or gave no response to this question. The remainder of the subjects cited a scattered group of other attractions: the most frequently mentioned being the Space Needle, the Great Britain exhibit, the NASA exhibit, the World of Tomorrow and the Food Circus.

Conclusion

While being dependent upon the use of recall, details of the visitors tour through the Pavilion relate well to observations made by the research group while working at the Pavilion. The most common travel patterns reported correlate well with those observed in an unsystematic manner during the Fair. The time estimates seem reasonable also. Pavilion officials said that the entire tour of the Pavilion took from two to three hours. Visitors who became tired toward the end of their tour no doubt sped through these portions of it.

An educational scientific exhibit is itself a little out of context in the atmosphere of a Fair. It is likely that those who peruse its contents have not totally left the fair atmosphere behind them; in fact, they are performing a necessary pilgrimage of their fair trip. But they tend not to come in with a studious attitude; rather, they wish entertainment. It is not difficult to visualize a Pavilion visitor who goes through the whole exhibit, only looking at what happens to catch his eye, reading very little, listening to one or two talks and coming out with little more than he went in with - except a very pleasant feeling about the whole thing, a feeling aided by its architectural setting. This may be the operating factor in many questions: the respondent says that "the Pavilion is certainly wonderful," that he would "come back to see it all," that he "disliked nothing." The feeling is very friendly and approving, but without any specific referrent other than the whole Pavilion.

Early in the project it was suggested that the Pavilion visit might be "akin to a religious experience" to many of the visitors. If so, we would expect many to comment on the "awe inspiring" nature of the Science Exhibit. Few did.

Of the specific things which were mentioned favorably, the films seem to have been more impressive than the other displays, since the two quite different motion pictures were mentioned more often than anything else.

The specific criticisms mentioned by our respondents were not uncommonly cited in the newspapers: difficulty in understanding exhibits, the overcrowding in certain areas of the Pavilion, and the long waiting lines to get into the first hall.

The purpose of Hall IV seemed only fuzzily perceived by the average visitor. Several factors may operate here. If the visitor followed the typical tour coming straight through the Pavilion from the beginning, he was apt to be quite tired by the time he arrived at Hall IV. This would partially account for the shortness of his stay in the area. Also, the message of Hall IV was to be gained only by reading, and mainly by reading the opening panels. It was generally not reiterated with each display. Such spotty reading as the average visitor did probably gave him little chance to catch the message.

In Brief:

1. Patterns of crowd flow were exceedingly varied; only the minority of respondents saw the total Pavilion.

2. Relative to its complexity, the typical visitor spent little time at the Pavilion.

3. Reactions to the Science Pavilion were strongly favorable, but marked by considerable vagueness.

4. Specific favorable comments tended to center around the two motion pictures (Hall I, "House of Science": Hall III, "Spacearium"), the Pavilion architecture, and Hall IV.

5. Specific negative comments tended to center around the displays, as beingtoo difficult; and around the crowded conditions of viewing.

6. The typical visitor spent relatively little time in Hall IV: few people saw it as communicating anything about the methods of science.

7. The Pavilion was most likely to be visited during the first or second trip to the Fair. Even repeat visitors to the Fair were likely to see the Science Pavilion only once or twice.

8. The Science Pavilion was rated above other fairground attractions by the majority of those interviewed.

CHAPTER XI

ON THE PSYCHOLOGY OF EXHIBIT DESIGN*

During these past months of work with the Federal Science Pavilion, we have come to a few tentative conclusions about exhibit design, and about the task which confronts the designer. Here I shall record our preliminary thinking. Although what follows draws upon the results reported in Chapters I to X, it goes beyond them; it tries to give a general framework within which the specific findings may be viewed.

From a designer's viewpoint, many things that happened at the Pavilion were unexpected. The crowd was better educated, and technically more sophisticated, than had been assumed. The crowd flow patterns throughout the Pavilion were much different; people did not go straight through the complex, taking the buildings in orderly sequence; they instead followed a variety of routes. Again, specific

* The discussion which follows draws on a variety of sources. Three people have been especially influential. It owes a special debt to Dr. A. E. Parr, of the American Museum of Natural History, who has served this project as consultant and mentor. I would also like to express my appreciation to Dr. Robert Weiss and Serge Boutourline, many of whose insightful comments on the Fair-going experience are reflected here. Mr. Nederkorn has kindly reviewed an earlier version of this chapter; the present draft incorporates many of his suggestions and criticisims.

design variables emerged as less important than the total gestalt of exhibits. This is most dramatically shown in Hall IV, where the placement of "landmark" displays influenced the viewing patterns for the entire building. Our results also suggest that the designers may sometimes communicate things which were not intended; and perhaps not wanted. In order to "make sense" of these and the many other findings, the following propositions are suggested:

1. People who go to an exhibit hall or a museum do not go to see single exhibits. They go instead to experience the exhibition as a whole. They are most interested in seeing displays they have heard about before; displays which are unusually impressive or newsworthy or emotionally appealing. The "high points" stand out in their minds and in their descriptions. The rest of the experience is subsidiary to such landmark events. They tend to glance at other exhibits and move away. In some situations they would find it impossible to stop and peruse the other displays in detail; crowd pressures push them along.

2. People experience each exhibit as a small part of their total viewing experience. Going through an exhibit hall is a process, just as viewing a movie is a process. The spectator walks past this display, then that one, observes still another. In a movie the film moves from scene to scene; in a display hall the audience moves from scene to scene. The audience watches a film, not as a series of unrelated scenes, but rather as a total experience which is more than a collection of discrete images. Each scene in a film, each shot, builds upon and enriches the ones that preceded it. Similarly,

moving through a series of displays produces a total impression on an audience, an over-all and cumulative experience. Each display interacts with those viewed before and those viewed after.

These considerations, when they are pointed out, may seem trivial and obvious. Yet it seems to me that they have profound implications for exhibit design. They suggest that the designer is not creating a static display, but rather is taking part in a process - a process in which the characteristics of crowd flow, and the <u>interaction</u> of exhibits in a sequence, must govern the design of any specific display.

This, in its implications, may be contrasted with another approach to exhibit design. The second approach in my ruminations, I have come to call the "static orientation."

A designer with the static approach creates his display as an artist creates a picture. In his mind's eye he sees a spectator who approaches his work and says, "What a fine display this is! So beautiful! So informative! Truly the artist who created this deserves a Design Award!" The display is conceived as a static object. The observer too is static; he stands mute before the display and drinks it in with his eyes, as if viewing a picture at the Guggenheim.

Perhaps the distinction between these two--the static and the process approach--will be clarified by considering an analogy with motion pictures. What would happen if a film-maker thought of his task in static terms? He would undoubtedly decide that his movie--his"exhibition"--should have a coordinating theme. He would further decree that each frame of his film should be esthetically pleasing, and that the lighting and color should be dramatic and appropriate. And then he would proceed with the filming.

The result would be atrocious. A montage of vaguely-related images would confront the audience. Scenes which would make sense if presented in the right order would be out of sequence, and so meaningless. Pages of complex script, requiring ten minutes to read, would be flashed on the screen for thirty seconds. There would be no rhythm, no drama. There would be no planned movement from long to short scenes, no attempt to communicate mood through variations in lighting. It would be -- to paraphrase William James -- "a blooming, buzzing confusion."

Yet is this so much different than designing exhibits without planning the rhythm and timing of crowd flow? Without taking account of the sequence in which displays are seen? Without considering the amount of viewing time available for each exhibit? And are displays in such a hall not apt to result also in "a blooming, buzzing confusion?"

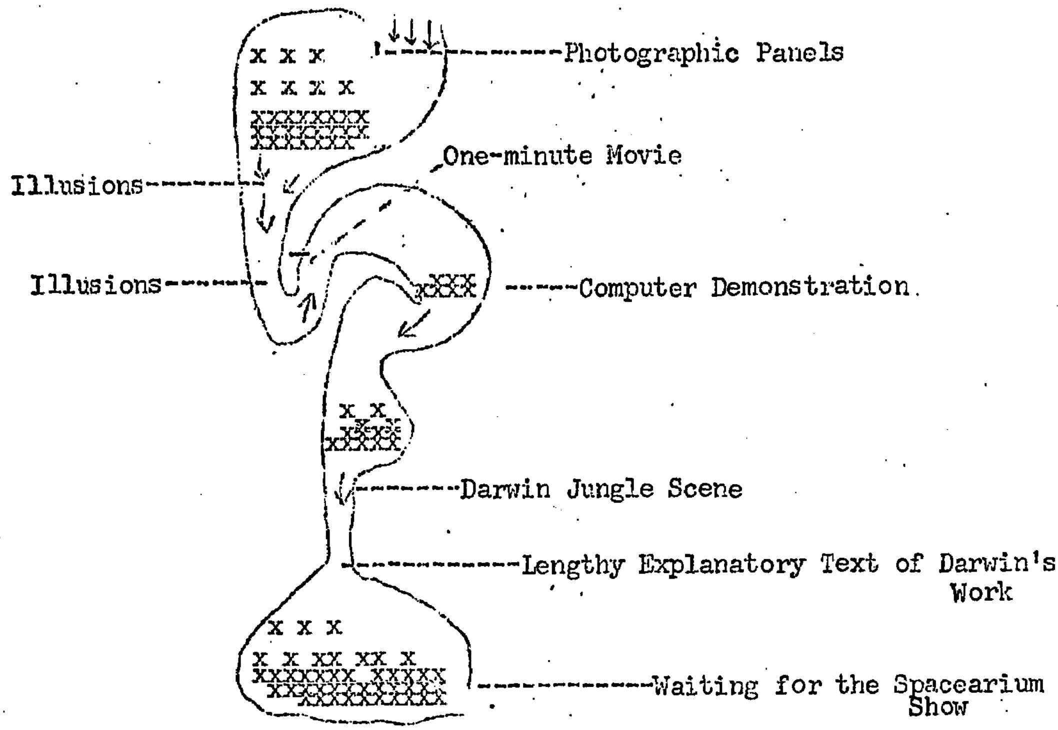
It is perhaps clear from the above what I mean by a "static" approach to design--it is one which takes no account of the time dimension, or the total complexity of the viewers' experience. And it should be equally clear what is meant by the process approach -- it is one which deals with time as a <u>major parameter</u> of exhibit design, and works within the complex framework of the total exhibition experience.

Here let me be a bit unkind, and illustrate this abstract discussion with some painfully concrete examples. The emphasis will be on the limitations of the "static" approach to design. But before I begin, two things need to be said. The first--that the critical tone of the following remarks should not imply that the exhibits were "bad" or that the Pavilion "failed." On the contrary, the individual displays were most excellent: pleasing to the eye, dramatic, informative. But future progress depends on an analysis of past errors, rather than on self-congratulations for partial success. Criticism is more valuable than praise if it suggests new solutions; and this I have tried to do.

Secondly, all of us associated with the Pavilion were aware of how much the exhibition design was a matter of committee decision, of last minute emergencies, of improvisation, and rushing deadlines. So when I point to the limitations of the "static" approach, I also know that certain flaws came, not from lack of design knowledge, but rather from the hectic conditions governing the Science Pavilion's development. The remarks to follow are concerned only with the ultimate outcome, and not the complex processes which led to that outcome. And, of course, these remarks are not all appropriate to other kinds ofexhibitions--museums, galleries, etc. There the problems differ, and gestalt effects may be not so marked.

Let us, then, consider Area II: it providing an especially varied group of exhibits and problems. The crowd-flow space might be diagrammed as shown on the next page. The diagram is not a floor plan; rather it shows the crowd behavior in a schematic form. Crowd blockage--areas where the crowd did not move--are indicated by dense clusters of "x" marks. Areas of constant flow under pressure are indicated by arrows.

from Eames' Film



What does it show? Let us examine it in more detail. The crowd emerging from the House of Science film was confronted with exhibit material--large photographic panels. There was lightning, a volcano in eruption, an autumn scene, all denoting sources of curiosity about the natural world. The basic notion was quickly grasped, just by glancing at each display. This in an area where people sometimes waited six minutes before entering the crowded ramp. The effect was like that given by a dragging movie scene, stretched out interminably.

Then to the illusion ramp, where the crowd was in constant flow, without time to stop and read. Here were exhibits which demanded concentration. Their basic message was complex--that science must distrust the unaided senses, and go beyond everyday observation. Yet for this message, which demanded time to assimilate, no time was avilable; the crowd flowed past like a tumbling stream.

Still on the ramp, the viewers were faced with a movie about sound and hearing. There was no chance to stop and watch it. They went on.

Followed an area which allowed a more systematic study of exhibits One crowd block developed around a computer in operation, where a human demonstrator gave a brief lecture. The people watching this demonstration acted like a cork in a bottle, keeping the rest of the crowd from passing by. The placement of this display also broke the continuity of several other exhibits--the crowd stood in front of other pertinent reading matter.

Past this blocked area there was more freedom of movement, and one could study other displays in sequence. It was apparent, however, that few people were pausing long before any single panel or display; certainly not long enough to absorb its information. When the crowd members were free to control their own time, they seldom spent more than 30 seconds with any exhibit.

Blockage again developed in front of the Darwin jungle scene. Here there was more display material to read, but it was so placed that one could not stand in line and at the same time study other exhibits. The jungle scenes themselves were quickly grasped. But the explanatory text--the point of the whole exhibit--was found immediately upon leaving the scene, at a spot where few people could possibly stop long enough to read it.

Finally, the crowd stood sometimes for 20 minutes or more and waited for the Spacearium to open. There were no displays to watch, nothing to do; they waited in a black and ill-lighted space where the crowd press was often so great that they could not even escape out a side exit.

It is apparent that the patterns of crowd flow were of crucial importance in the exhibit-going experience. The crowd governed all. After the Fair was over, I wandered through Area II at my own pace, standing before the displays which attracted me, dawdling on the illusion ramp, spending an enjoyable three hours. But then I could treat each display as a static thing in itself. During the Fair each display was influenced by the timing of the crowd flow. The designers' neglect of crowd movement destroyed much of the impact of the individual exhibits.

What might a designer with a "process" orientation have done? Let us assume that the same basic floor plan was used. A consideration of the crowd flow would have led to a much changed sequence of displays. Areas of maximum crowd blockage would call for displays which gave much information, and with as much general appeal as possible. A somewhat revised movie on sound and hearing, for instance, might have been shown before the entrance to the illusion ramp. The "moral" of the illusion ramp might have been illustrated and underlined. The exhibits on curiosity might have been made more complex, and arranged so that they could be viewed while waiting to go onto the ramp. Quite otherwise with the displays on the ramp itself; they would have been designed so as to be quickly perceived, their message grasped in seconds. Once past the ramp, in the area allowing a free choice of exhibits, the design task would have been differently approached. Each panel would have had an "establishing sentence" to show the theme of the display. This could be read in three seconds or so. If the viewer was intrigued by the headline, he could pause and find a longer--but still short--lead paragraph or image which communicated the main idea. If still curious, he could then study the more complex parts of the display. And, of course, "live" demonstrations would be placed so that they created no accidental bottlenecks.

Again, complex displays would have been placed at the next area of crowd stoppage, before the Darwin Jungle scene. A brief film on Darwin's work would have been helpful. In any event, the explanatory material would have been placed where it could be easily seen, so as to give substance and meaning to the simulated jungle.

Similar considerations would have governed displays in the Spacearium waiting area. Here, in fact, a live demonstrator would have been appropriate: someone who discussed the historical basis of scientific cosmology.

I am no designer; a professional would undoubtedly develop far more creative exhibits than are suggested here. But the main principles would remain. Areas of constant crowd flow would have terse, quickly grasped displays. Areas of crowd stoppage would have more complex exhibits, pitched to a general audience. Areas of variable crowd flow, allowing for free choice of exhibits, would have displays which could be taken on the run, or perused at leisure. Whatever the specific design of an exhibit, its basic nature would be set by the crowd flow.

In brief--to the process-oriented designer, the most basic design parameter is the pattern of crowd flow.

Exhibit Interaction

This discussion so far has dealt mainly with crowd flow as a process, and the difficulties which result when its effects are overlooked. But this is only half of the story. Viewing an exhibition is a total experience, occurring through time. Displays interact with each other: the first exhibit of a sequence influences the way in which later exhibits are seen. One can set up certain principles, certain guide lines, which describe this interaction. These too are important to the process-oriented designer.

In what follows I shall be talking about display sequence. The rules I shall suggest are derived from the findings of perceptual and cognitive psychology. They are illustrated with examples from the theatre, music, and poetry--all arts which depend on a sequence for their effect.

The first rule--learning and perception occur within a more general framework of understanding. Consider what happens when one is confronted with an unfamiliar type of music. At first all seems confusion. But gradually the listener becomes aware of certain themes, of certain recurring rhythms. A general structure emerges. The listener "gets the ideas." Having an over-all "map" of the music in his head, he then begins to notice variations on themes, begins to notice more subtle changes in rhythm. In psychological terms, he forms a general gestalt, and then proceeds to finer discriminations.

The second principle--communication is easier when a message can be clearly discriminated from other messages. A black dot on a white page is more easily seen than a black dot surrounded by gray dots. A musical stanza is more obvious if it be markedly different from the stanzas which surround it. The effect of tragedy is heightened if flashes of humor are introduced. In all of these cases contrast increases effectiveness. In psychological terms, the greater the difference between figure and ground, the more easily a gestalt is formed.

A third principle is less well established, but of considerable importance. It is this--that within limits, the observer's activity in perceiving adds to the impact of the communication. In poetry, for instance, we speak of "freshness of imagery;" this means that the words are put together in novel ways, yet communicate. The reader is forced to make an effort to perceive the message; the effort in itself heightens the effect. An example--not from poetry but from folk-language: "He has the kind of face that would scare the flies off a gut wagon." This has the same objective meaning as "He has an exceedingly ugly face." Yet, the former has much greater impact, an impact which comes mainly from the effort of combining discordant verbal elements into a single gestalt.

Painting, at least since the Byzantine period, illustrates the same principle. The history of art may be viewed as a never-ending attempt to make new perceptual demands upon the viewer, forcing him to construct a fresh gestalt from unfamiliar elements. Thus the Italian renaissance introduced new compositional schemes; the illusionistic effects of vanishing-point perspective were adopted; the Baroque broke the picture surface into new elements by the play of light and shadow; genre painting was introduced; and so on. Psychologically, what is important here is not that "technical difficulties" were overcome; or that painters solved the problems of representing three-dimensional space on a two dimensional surface. Rather it is that the innovation added a fresh impact, forcing the viewer into a new perceptual effort and so producing a sense of heightened recognition.

A subsidiary principle should also be cited--that the achievement of a gestalt is itself satisfying, and its lack aggravating. Two examples--the man who lies awake waiting for his neighbor to drop the second shoe; and the feeling of dissatisfaction when a musical chord is not resolved. Recent work on "cognitive dissonance" seems to me illustrative of the same principle. In all these cases, failure to form a gestalt produces a feeling of incompleteness.

To summarize--four psychological principles seem to me of crucial importance in understanding the effects of display sequence. They are:

1. Perception proceeds by forming increasingly finer discriminations on the basis of a more general gestalt.

2. The greater the contrast between a stimulus and the surrounding field, the more easily a discrimination will be formed.

3. Within limits, the greater the observers' activity in forming a percept, the greater the impact and "immediacy" of that percept.

4. People feel a sense of dissatisfaction when they are unable to form a gestalt, and are pleased when they can.

As general statements these are fairly abstract; in the next few pages I shall attempt to show their application to the concrete problems of exhibit design in the Science Pavilion.

<u>Principle 1</u> <u>Perception proceeds from a general framework to increasingly finer discrimination</u>.

We must distinguish here between the general cognitive framework which governs the designer, and that which is perceived by the viewer. The example of Hall IV has been cited earlier. As noted in Chapter X, few people were able to state even the major theme of the exhibit there. In Hall II also, the basic themes were well spelled out. The viewer was to emerge from the "House of Science" film and be confronted by displays illustrating the sources of man's curiosity; from there he was to walk down a ramp showing the limitations of man's senses in satisfying his curiosity; and at the foot of the ramp were demonstrated some of the instruments man uses to extend his senses. The rest of Area II was devoted to science and its historic development. Thus the section on mathematics started with the primitive concept of number, progressing from there to a demonstration of the I.B.M.

computer. The section on biology started with Darwin's work and took the viewer through classical genetics to the recent studies of the structure of DNA. The final section before the Spacearium dealt with cosmology, beginning with the Ptolemaic system and proceeding to a "popularization" of Einstein's general theory of relativity. A sequence of displays was obvious--to the designer. It was perhaps not as obvious to the viewer.

From the viewer's point of view, he passed from the "House of Science" film and found himself in a hall with a number of striking photographs and unique sound effects. After waiting much too long he filed down a ramp, viewing several illusions and a tilted town which made him (sometimes) feel out-of-balance. Off the ramp he wandered past a plethora of displays until he arrived at the Spacearium--where he waited in line again. Many of the displays were striking; but our observations suggest that a few people saw them as an historical sequence. Their reactions were either at a very general level, or else were focused on specific exhibits.

The viewing experience apparently gave the audience little in the way of a general cognitive framework. Yet this was not an inevitable lack. As an illustration of another approach--one very sensitive to the need for a generalizing framework--let us turn again to the analogy of the documentory film. Imagine that one was making a film showing that science procedes from curiosity, that man's senses are limited in satisfying his curiosity, and that he must devise special instruments if he is to extend the range and accuracy of his senses. The film maker might use many of the images adopted by the designers in

Area II. But the images would not rest alone. Instead, the director would make very sure that each scene added some information to the over-all message. He would not hesitate to drive home the important points. Example:

Visual	Audio
Fade out (from scientists at work) to	(narrator) What are the roots of science? What is its source?
	In a single word -- curiosity.
Lightning flash	(varied voices) What causes the lightning flash?
Moon in phases	Why does the moon dwindle and grow large?
Gull in flight	Seagulls -- how do they fly?
(swing pan to)	(narrator)
Child watching gull in flight, open mouthed.	Curiosity.
	But to answer questions,
Child running, pretending to fly.	Curiosity is not enough.
	Observation is needed. . .
	Careful, painstaking, accurate. . .
	And man's senses are limited.
	He can be fooled.
	Length can be misleading.
Muller-Lyer Illusion	Look at these lines -- which one is longer?
Ruler placed over illusion	The one at the right? No. Both are the same
Close up of ruler numbers	Precise measurement is the first step

Etc.

In spite of its amateurishness, this brief script illustrates the way in which a film places each image within a larger framework of communication. The general message is repeated, the specific image serving as an example. Sometimes, of course, one need not pound so heavily on the listener; the gist of a message can be established by narration and the rest of the communication carried by the eye and by music. But the image itself is seldom enough.

It seems to me that the same principles apply in exhibit design. The designer is not designing specific exhibits; he is designing a sequence of exhibits. The sequence should be carefully programmed so that each specific display--each image--adds something important to the over-all effect. The designer should not be afraid of driving home the generalizing statements, nor should he avoid repetition when two displays illustrate the same theme. Not only should the displays be as carefully programmed as anything that goes into a teaching machine, but the specific composition and material of the display should also add thematic continuity. Thus it might have been appropriate to include illustrations and animation from the prior House of Science film in designing exhibits for Area II, where similar historical material was covered.

In sum: the provision of a general framework, tying together discrete displays in a meaningful sequence, calls for a more programmed approach to exhibit design. It seems reasonable that this should be carefully worked out, in script form, before a single display is developed.

<u>Principle 2 The greater the contrast between a stimulus and a surrounding field, the more easily a discrimination can be formed.</u>

This law is of course basic to all art; it tells the designer nothing new. Yet I have thought it worth emphasizing because it is crucial, not only to single exhibits, but to exhibit sequences as well.

Although the designers varied the heights and shapes of their displays, although they used different colors when planning displays on different topics, yet in some respects the exhibits were monotonous. Save for the "House of Science" film humor was entirely absent. The feeling-tone of every display was profound and solemn--"These are impressive matters. These are important, gigantic things you are looking at. Be impressed!" There was little use of texture, little attention paid to the senses of touch or smell. Some sound was used, but without adequate attention being paid to the acoustics of the display or the decibel level of the hall, so much of the narration was relatively inaudible. These things too could have been more effectively programmed if the displays had been designed as a sequential experience.

<u>Principle 3 The greater the observer's activity in forming a percept, the greater the impact and "immediacy" of that percept.</u>

For our purposes, this principle might be rephrased as, "Make the audience feel the need to satisfy their curiosity." Two steps are involved--the arousing of curiosity, and providing a means for its satisfaction. (Note that this principle is applicable, not only to single, static displays, but also to sequences of displays.)

Most of the exhibits were presented in a straight-forward, no-nonsense manner. One looked at illusions, read about mathematics, listened to demonstrators. There was little attempt to tease the audience into personal involvement.

In our own project, we found that people would ask to play with the automated teaching machines we used for interviewing, fascinated by the different responses they were getting to their answers. And after the interview, some of the respondents would go through the hall again, just to find the answers to questions they had missed. In all these cases, the "viewer" had been left with a sense of incompleteness, of unsatisfied curiosity.

It seems to me that one might build on the power of personal curiosity in designing display sequences. The first of the exhibit experiences might be designed only to arouse curiosity. It would provide a personally-involving challenge. The remainder of the display would be designed to satisfy this curiosity.

An example might be helpful as illustration. What follows is a novice's attempt at exhibit design; the example itself should not be taken very seriously. But it does perhaps give specificity to an abstract discussion.

Suppose that we were presenting a display which dealt with genetics and the DNA molecule. What kind of initial exhibit would arouse curiosity? What initial exhibit would be personally challenging?

Visualize the following display. Imagine that the crowd comes to an area where it is funnelled through a narrower passageway. In the process of funnelling, and while it is in the passageway, it will be exposed to an initial, curiosity-provoking message.

As the people stand before the passageway, waiting to proceed, a TV camera slowly pans the group. Their images appear on a screen over the entrance. The images fade away and a single human figure appears--possibly the da Vinci drawing of human proportions. Overlaid on this image is a text:

"Your body seems stable,
Secure, slow to change
It is not.
Under the microscope it looks like this."

The image zooms down onto the hand of the figure. The hand disappears. Physiological features come into view: arteries, muscles, nerves. The camera continues zooming downward. Single cells appear, in constant activity. A new text appears on the screen:

"Each cell, living, dying,
Forming others like itself."

At this point the image fades. After a brief pause the sequence starts again. The sequence takes just long enough for each person to have seen it while standing before the passageway.

Inside the passage, is a single sign. White illuminated letters on a dark panel above the crowd spell out--

"THE BASIC LAW OF LIFE--CELLS FORM
OTHER CELLS EXACTLY LIKE THEMSELVES"

The crowd then comes to a somewhat larger area of the passageway. A voice says quietly,

> "Cells form other cells like themselves. . . .
>
> This law keeps you alive. . .
>
> Your cells are being born, constantly,
>
> Are dying, constantly,
>
> Yet are passing their basic patterns to new generations of cells."

Displays along the side show mitosis in various stages and with various kinds of cells. There is a blown-up photograph of the Drosophila chromosome, genetic bands showing, et cetera.

Past this area, the passageway gradually widens. A series of spot-lighted panels, just above the crowd and angled outward, show the following message. The spotlight swings in sequence--or, alternatively, the signs are back-lighted in sequence.

> "Transmitting the basic pattern.
> Forming new cells exactly like themselves.
>
> How?
>
> What strange code inside the splitting cell
> Tells the new cell
> how to grow?
>
> How to absorb food?
> How to reproduce itself?
>
> How to take its place in the great organization of the body?
>
> What code?"

Note that these signs, shown in sequence, may by themselves establish a certain speed of crowd movement. Between the signs are panels illustrating cellular activity. The final panel shows a zoom from heart cells to the heart itself, pumping. The final sign is right before the exit from the passage way. It reads:

"HERE IS THE STORY.

THIS IS HOW SCIENTISTS

ARE SOLVING THE CODE.

HERE IS THE WAY YOUR CELLS KEEP YOU ALIVE."

The crowd then comes to the display proper. Here various exhibits are avilable; people can browse amoung them, picking the particular ones they wish to examine in more detail.

It should be clear that this initial group of displays communicates no "new" information. Most people are vaguely aware that body tissues are composed of cells; that cells reproduce by division; and that heredity is transmitted from cell to cell. But the initial section has awakened their curiosity. It makes their vague information suddenly seem important; it makes them wish to learn more. Or so one hopes.

I must confess that the exhibit design outlined here seems to me, on rereading, somewhat flat and lacking in dramatic appeal. But I can take refuge in the awareness that I am not a professional designer. I suspect that with the same themes a skilled designer could do much more.

In Brief

1. The displays in the Science Pavilion would have been more effective had adequate attention been paid to the effects of crowd flow and crowd pressure.

2. In the exhibit halls, not enough thought was given to the effects of display sequence, and the ways in which early displays influence the way later ones are seen.

3. Several principles were suggested in planning for crowd flow:

   a. Areas of constant crowd flow should have terse, redundant, quickly-understood displays. Such displays are most useful with limited introductory material to which everybody should be exposed.

   b. Areas of crowd stoppage should have more complex displays which can be perused while waiting to move. These need to be pitched to a general audience.

   c. Areas of variable crowd flow allow the spectator to make choices among exhibits. Displays here need a single, easily-seen sentence showing the theme of the display, a lead paragraph or image which communicates the main idea, and a more complex message which can be studied by the more interested.

4. Several principles are also suggested in planning for exhibit sequence. These are:

   a. The designer should provide a general framework of understanding for specific displays. The sequence of displays should be carefully programmed, with the general theme and message made crystal-clear.

   b. In programming displays, the designer should vary the mood and rhythm of the display-experience, being not afraid of humor or textural effects when they can be used to make the exhibits more varied or more striking.

   c. In programming displays, some experiences should be designed not to communicate information, but only to arouse the audience's curiosity and make the topic personally relevant. The audience needs motivation for the effort of display viewing.

5. In the most general terms, it is suggested that exhibit design should utilize a "process" rather than a "static" approach. Designers should not view themselves as designing a specific display, in the same way as an artist designs a single specific picture. Rather the designer should think in terms of sequence of exhibits, each display adding some nuance to the total experience. He should think of his task as similar to that of a motion picture director. No matter how fine any particular shot or scene--or display--may be, the total viewir experience takes precedent.

APPENDICES

I Preliminary Non-Focused Interviewing on Science and the Scientist

II SCINA Probe: The Preliminary Attitude Questionnaire

III Principal Axis Factor Analysis of Semantic and Item Ratings for the Concept "Science"

IV Analytic Iterative Rotation of Factors and Item Ratings for the Concept "Science"

V Principal Axis Factor Analysis of Semantic and Item Ratings for the Concept "Scientists"

VI Analytic Iterative Rotation of Factors and Item Ratings for the Concept "Scientists"

VII Final Attitude Questionnaire

VIII SCINFO Probe: The Preliminary Information Questionnaire

IX Information Pretest Item Analysis

X Final Information Questionnaire

XI Final Background Questionnaire

XII Percentage Distribution of Background Characteristics

XIII Tabulations of Semantic Differential Ratings for the Concept "Science"

XIV Tabulations of Semantic Differential Ratings for the Concept "Scientist"

XV Raw Frequency Distribution of Responses and Chi Square for Information Test

XVI Percentage Distribution of Responses for Information Test

The above appendices may be obtained from:

Institute for Sociological Research
University of Washington
Seattle 5, Washington